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ASTRONAUTICS AND AERONAUTICS, 1978

A CHRONOLOGY

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA SP-4023

ASTRONAUTICS AND AERONAUTICS, 1978

A Chronology

The NASA History Office

The NASA History Series

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NASA maintains an internal history program for two principal reasons: (1) Sponsorship of research in NASA-related history is one way in which NASA responds to the provision of the National Aeronautics and Space Act of 1958 that requires NASA to "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof." (2) Thoughtful study of NASA history can help agency managers accomplish the missions assigned to the agency. Understanding NASA's past aids in understanding its present situation and illuminates possible future directions. The opinions and conclusions set forth in this book are those of the author; no official of the agency necessarily endorses those opinions or conclusions.

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Preface

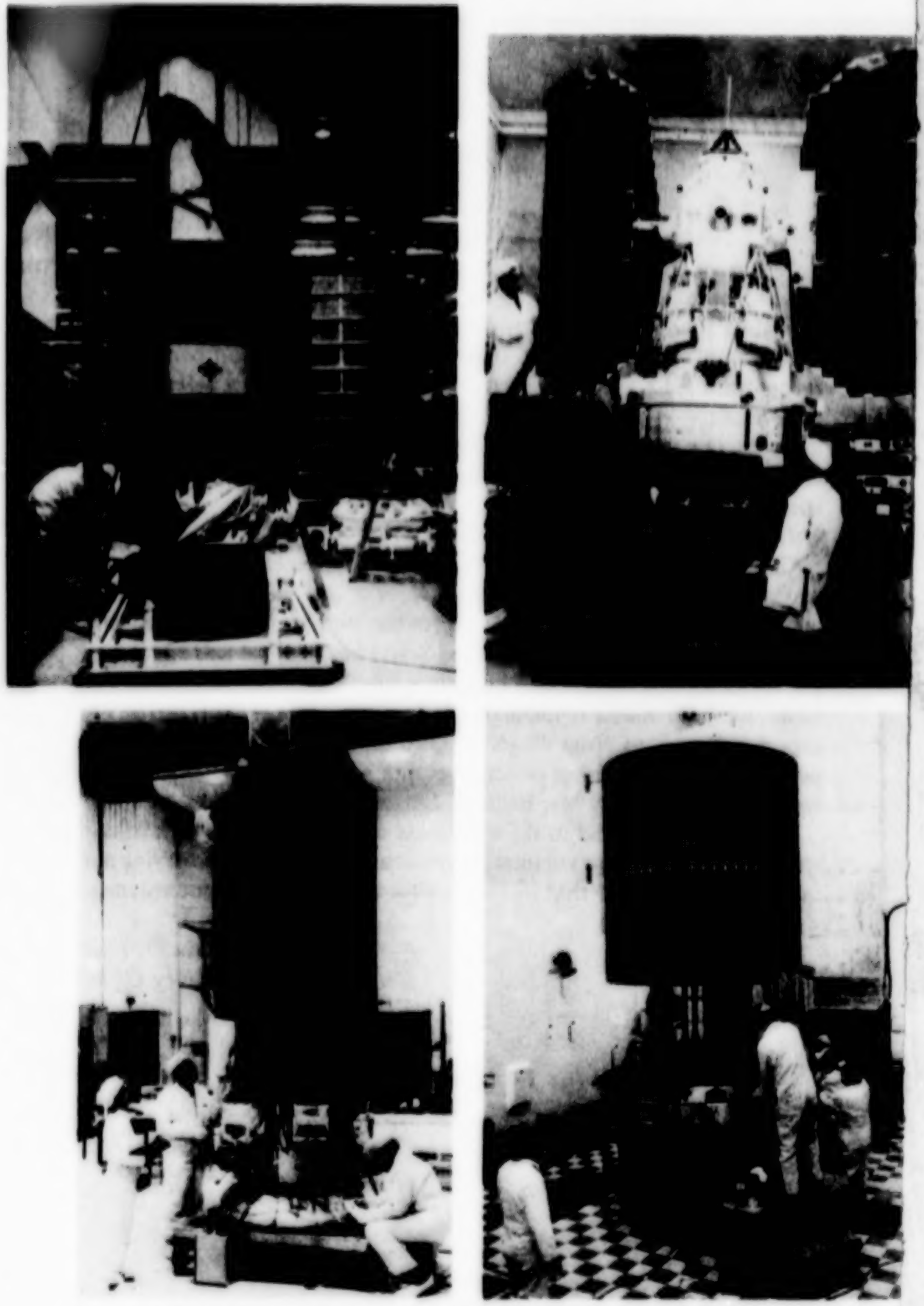
Astronautics and Aeronautics for 1978 is the 18th volume in a series of annual chronological digests of principal events in the fields of astronautics and aeronautics. Initiated in 1961 with a compendium of events from 1915–1960, this series is designed to serve as a reference for policymakers, reference librarians, and researchers. Each entry is followed by one or more citations of sources to which users may turn for further information on the particular event or development being chronicled.

The *Astronautics and Aeronautics* series is one way in which the NASA History Office has attempted to implement its charter to disseminate information about the activities of the National Aeronautics and Space Administration, and to provide support for historians and other researchers in the area of United States aeronautical and space programs. As a result of staff and budgetary limitations, the NASA History Office has been unable to maintain the annual currency of this series. We expect, however, to bring the series up to date with a forthcoming compendium volume covering principal events over a six-year period. This volume was written by Ms. Bette R. Janson.

Reliability is essential to the usefulness of any reference work of this scope. As with previous volumes, readers can contribute by notifying our office of any errors so that we can publish them in subsequent volumes.

Sylvia D. Fries
Director, NASA History Office

July 1986



Four varieties of spacecraft launched by NASA in 1978: top left, scientific international ultraviolet explorer IUE 1, *launched Jan. 26; top right, earth-resources satellite* Landsat 3, *launched March 5; bottom left, environmental meteosat* Tiros N, *launched Oct. 13; bottom right, comsat NATO 3C, launched Nov. 18.*

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Contents

Preface iii
January 1
February 25
March 49
April 77
May 103
June 129
July 155
August 181
September 209
October 235
November 259
December 289

Appendixes

A. Satellites, Space Probes, and Manned Spaceflights, 1978 317
B. Major NASA Launches, 1978 347
C. Manned Spaceflights, 1978 351
D. NASA Sounding Rocket Launches, 1978 353
E. Abbreviations of References 361
Index 367

Illustrations

First women named by NASA as astronaut candidates 9
Space Shuttle orbiter Enterprise 72
Six astronauts awarded Congressional Medal of Honor 237
Photo mosaic from the Viking orbiter 267
NASA's second high-energy astronomy observatory 269
Artist's concept, Pioneer Venus orbiter and multiprobe 281

January

January 2: Aviation Week and Space Technology magazine reported that President Carter would soon receive from Secretary of Defense Harold Brown a plan for a unified U.S. space policy covering all government and private-sector programs. The plan was the product of a policy-review committee headed by Brown and consisting of representatives from NASA, the Dept. of Agriculture, Joint Chiefs of Staff, CIA, DOD, the office of the President's national security adviser, and the Office of Science and Technology Policy; the Interior Dept. and NOAA had participated in a steering committee under the main group. After evaluating the effect of the U.S. space program on foreign policy, national security, and overall economic benefit, the group had agreed that national security considerations were the main hindrances to formulating a national space policy. The group had considered space-arms control (maximum pacification of space, with limitations on killer satellites); availability of reconnaissance-satellite data (greater federal agency access); regulation of private-sector remote sensing (resolution limits); interagency management (a coordinating committee, to be chaired either by DOD and NASA, or by the President's science adviser); broadcast satellite policy (no restrictions on signals crossing national borders); and certain intelligence, DOD, NASA, NOAA, and civilian programs. (*AvWk*, Jan 2/78, 14)

• *AvWk* reported NASA's announcement that it would send *Pioneer 11* to fly just outside the rings of Saturn as a pathfinder for two Voyager spacecraft scheduled to reach Saturn in 1980 and 1981. Passing 15 000mi rather than 3700mi from Saturn's surface, the new course would place *Pioneer 11* at about the same distance from Saturn as the trajectory of *Voyager 2*, if NASA should decide to use Saturn's gravity to hurl *Voyager 2* toward Uranus. The outside trajectory would permit NASA to achieve the maximum science return for all three spacecraft. *Pioneer 11* should reach Saturn in Sept. 1978. (*AvWk*, Jan 2/78, 15; *Lewis News*, Jan 6/78, 2)

• President Carter's $100 million reduction in MX-missile FY 1979 funding would not prevent DOD's continuing advance MX development for another yr, *AvWk* reported. The remaining $160 million would cover costs of assessing basing modes and alternatives for the missile. The President's decision to continue MX without starting engineering development would delay initial operational capability until 1987. Key administration officials doubted that MX would ever be deployed, said *AvWk*, because of its links to future SALT agreements preventing deployment of mobile-based systems. (*AvWk*, Jan 2/78, 13)

January 5: NASA reported a board of inquiry's findings on the Sept. 9, 1977, failure of an Atlas-Centaur launch vehicle destroyed 55sec into the flight. Launched from Kennedy Space Center, the vehicle had carried an Intelsat IV-A. The board attributed failure to a rupture in the high-pressure "omega joint" in the Atlas-stage gas-generator discharge line, caused by contamination during production. Technicians had tested joints on all completed vehicles, and all those at KSC had passed; a few in the factory that were corroded or questionable had been replaced. Changing the fabrication process should prevent further contamination, the report stated. (NASA Release 78-3)

January 6: Lewis Research Center reported it had signed a $24 million 1 yr contract with Honeywell, Inc., Avionics Division, St. Petersburg, Fla., for management and engineering support of Centaur inertial guidance. This automatic self-contained navigation and guidance system with a digital computer unit would permit Centaur to compute and adjust its flight for delivery of a spacecraft to a preselected orbit without ground command. The nation's first high-energy liquid-hydrogen liquid-oxygen rocket, the Centaur, as an upper stage on both Atlas and Titan III boosters, had helped launch *Voyager 1* and *2*, scheduled to fly by Jupiter and Saturn in 1979 and 1980. (*Lewis News*, Jan 6/78, 2)

- Preliminary analyses of *Viking Orbiter 1* (VO-1) data on the Mars satellite Phobos revealed low density and a spectral reflectance and low albedo that suggested a composition similar to type I carbonaceous chondrites, reported *Science* magazine. VO-1 had obtained a spectacular picture sequence at 100km, an encounter by far the most demanding navigation performance of any interplanetary-spacecraft exploration to date. Since Phobos had a mean radius of only 11km and was only partially illuminated when viewed during the flyby, the VO-1 position relative to Phobos had required accuracy of within a few kilometers. Imaging data had revealed small positive features (hummocks), small craters with bright ejecta blankets, dark material on the floors of some craters, large variations in topography, and an abundance of linear features resembling crater chains. Further analysis would refine density estimates to determine Phobos's origin. (*Sci*, Jan 6/78, 61)

January 6-7: NASA launched *Intelsat IVA F-3*, fifth of a series of improved commercial communications satellites, at 7:15pm EST Jan. 6 from Cape Kennedy on an Atlas-Centaur into a transfer orbit. ComSat-

Corp had fired the apogee kick motor Jan. 7, putting the satellite into near-geosynchronous orbit. After initial positioning at 74°E the satellite would be moved to 60°E as backup to *Intelsat IVA F-6*, and was scheduled to be on station at 63°E by mid-June.

Intelsat IVA F-3 had an overall height of 6.99m and a diameter of 2.38m. Height of the solar panel was 2.82m. Liftoff weight was approximately 1515kg (3340lb); in-orbit weight after apogee motor firing, 825.5kg (1820lb). Design life was 7yr.

Ten Intelsat IV and IVA satellites were currently in synchronous equatorial orbit over the Atlantic, Pacific, and Indian Oceans, providing full-time telephone, teletypewriter, data, and television services to 107 countries, territories, and possessions. The Intelsat IVA had almost two-thirds greater communications capability than the Intelsat IV series, with about 6250 two-way voice circuits and 2 television channels in its system configuration. The number of operating transponders had increased from 12 to 20. Improvement of the antenna system had produced greater effective bandwidth through frequency reuse by beam separation: for Indian Ocean service, the east-pointed beam of *Intelsat IVA F-3* would illuminate Japan and Southeast Asia using a 320MHz bandwidth, and would reuse the same 320MHz bandwidth in the west beam illuminating Europe and Africa. In addition to eight east-beam transponders and eight west-beam transponders, four transponders connected to an earth-coverage antenna would illuminate all stations in the Indian Ocean region.

The Communications Satellite Corp. (ComSatCorp), U.S. member of INTELSAT, would be management services contractor for the satellite system; ComSatCorp on behalf of INTELSAT would reimburse NASA under a launch-services agreement for costs of the Atlas-Centaur and the launch. The Intelsat IVA program represented an investment by 101 nations of approximately $295 million (US); this launch had cost approximately $47 million ($18 million for the satellite and $29 million for the launch vehicle and related services). (NASA Release 77-250; MOR E-491-633-78-5 [prelaunch] Jan 5/78, [postlaunch] June 23/78; *W Star*, Jan 7/78, A-5)

January 9: NASA announced selection of 16 experiments in space technology for the Long Duration Exposure Facility (LDEF) mission, scheduled as payload for the first Space Shuttle operational flight in 1980. LDEF, managed by Langley Research Center, was a reusable unmanned free-flying structure carrying various technical and scientific experiments in special trays, providing an easy and economical means to conduct primarily passive experiments in earth orbit.

NASA had selected the 16 experiments from 190 candidates that responded to an opportunity notice distributed in June 1976. Investigators selected to date represented 6 universities, 6 private organizations or research institutes, and 5 NASA centers. Seven experiments were from France, 2 from England, and 1 from Canada. R&D value, compatibility with LDEF and other experiments, and effort cost had been selection criteria. Technical areas included materials, thermal-control coatings, detectors, power, micrometeoroids, electronics, lubrication, optics, and space-debris detection. Eighty percent of LDEF's experiment trays had been filled; the remaining space would contain micrometeoroid-detection panels. LDEF would remain in orbit 6 to 12mo for experiment exposure to space environment. The Space Shuttle orbiter would retrieve and return it to earth; experiments would go to their investigators for data analysis. (NASA Release 78-1)

• NASA announced appointment of Kenneth Chapman as associate administrator for external relations, effective Jan. 8. Chapman had been acting in the position since its creation Nov. 8, 1977, and had been assistant administrator for DOD and interagency affairs since joining NASA April 1, 1977. Chapman would be senior policy official responsible for integrating NASA activities in public, legislative, university, community, interagency, and international affairs. Chapman had come to NASA from the Nuclear Regulatory Commission. He retired from the Air Force in 1975 after a 29-yr career. (NASA Release 78-4)

• KSC had begun preparation for launching Shuttle Orbiter 102 in Oct., *Spaceport News* reported. Construction of new facilities and modifications to existing ones were proceeding on schedule. The orbiter-landing facility and orbiter-processing facility had been the only new facilities built at KSC to support Shuttle operations. Other preparations included modifications of existing facilities originally designed and built to support Apollo/Saturn operations. KSC would transform hanger AF at Cape Canaveral Air Force Station into a solid-fuel rocket-booster recovery and disassembly facility. (*Spaceport News,* Jan 9/78, 1)

• The Commerce Department had predicted the total value of U.S. aerospace-industry shipments of complete aircraft, engines, and space vehicles at $22.2 billion this year, reported *Aviation Week*. This was a 21% increase over the estimated value of $18.3 billion for 1977, resulting from a surge of orders for large commercial transports in the first half of 1977 for 1978 delivery. A hundred data collectors working for DOC concluded that the U.S. would maintain worldwide preeminence in aerospace; that aerospace exports would continue to provide the largest U.S. manufacturing trade surplus; that sales, shipments, and profits would move up with the demand for large transports causing the greatest optimism; that general aviation would continue to grow in 1978; and that economic growth in 1978 would increase passenger traffic about 6% over 1977, to 200 billion passenger miles. Aerospace imports, the magazine said, would probably remain low—about 2.2% of U.S. consumption in 1977—and would probably cost the U.S. about $648 million in 1978. (*AvWk*, Jan 9/78, 15)

- NASA announced plans for 25 launches in 1978 and support of 3 Atlas-F space launches from Vandenberg Air Force Base. The 1978 missions would be almost equally divided between those directly benefiting people (for communications and geodetic, environmental, navigation, meteorological, and earth-resources studies) and those primarily for scientific and exploratory research. Fifteen launches would be for paying customers, including the European Space Agency (ESA), ComSatCorp, the U.S. Navy, Japan, NOAA, the United Kingdom, and Canada. Cape Canaveral had been scheduled for 10 Delta launches and all the Atlas-Centaur launches; one Delta would be launched from the Western Test Range at Vandenberg AFB. (*Spaceport News,* Jan 9/78, 1; *Goddard News,* Jan/Feb 78, 1; *AvWk*, Jan 9/78, 48)

- Lockheed-Georgia Co. announced it would test its USAF C-5A transport as a cruise missile launch platform, *Aviation Week* reported. Lockheed noted that the platform could accommodate the USAF/Boeing air-launched cruise missile (ALCM), the Navy/General Dynamics Tomahawk (TALCM), and air-to-air self-defense missiles with equal facility. Key features would include no need for structural modifications to the aircraft or its systems or subsystems; operation essentially by gravity; and flexibility that would allow installation on any C-5, Lockheed C-141, or C-130 aircraft. The launch system would maximize flight safety, as missiles would be loaded in launch position, secured, and released and moved only on a launch command, Lockheed officials emphasized. (*AvWk*, Jan 9/78, 40)

January 10: The Federal Aviation Administration would demonstrate in Europe and Africa in early 1978 a family of advanced all-weather landing systems, Administrator Langhorne Bond announced. The FAA would airlift three versions of the time-reference scanning-beam microwave landing system (TRSB/MLS) developed by the U.S. and Australia to four overseas sites in Jan. and Feb. to demonstrate the new approach-and-landing aid at various airport environments. TRSB/MLS versions designed for small community airports would be demonstrated Jan. 23 and 24 at Kristiansand's Kjevik Airport in Norway, and in Feb. at Dakar's Yoff Airport in Senegal; at the Nairobi, Kenya, airport; and at Gosselies Airport outside Brussels, Belgium. FAA would demonstrate an expanded TRSB/MLS system Feb. 1-3 at the Brussels airport. The

U.S. and Australia had proposed TRSB/MLS to the International Civil Aviation Organization (ICAO) as the new worldwide standard all-weather approach-and-landing guidance system. (FAA Release 3-78)

January 11: KSC announced award of a $3.5 million contract to Federal Systems Division, Honeywell Information Systems, for delivery of a central data subsystem for Shuttle launch processing, consisting of two large scale computers sharing a common memory that would store test procedures, a master-program library, pre- and post-test data analyses, and other types of data to support Shuttle checkout, countdown, and launch. KSC had procured the subsystem for Vandenberg AFB for a second Shuttle launch and processing facility. (KSC Release 3-78)

- Marshall Space Flight Center (MSFC) announced that Corning Glass Works, Canton, N.Y., had begun work on a foot-thick primary-mirror blank for the Space Telescope, for which the center would have overall management responsibility. The telescope had been scheduled for launch in 1983. Corning would deliver two 8ft discs to Perkin-Elmer Corp. for grinding and polishing and telescope assembly; Lockheed Missiles and Space Co. would build the primary spacecraft and support system, and integrate the complete telescope. Glass had been used for the mirror blank as it would change shape only slightly with temperature changes during viewing; the titanium-silicate mirror blank would have zero expansion on a scale used by physicists. Aperture of the mirror blank was about 94in; diameter of the center hole was about 2ft. (*Marshall Star*, Jan 11/78, 4)

- MSFC announced successful completion of the first test of the Space Shuttle external tank, a major milestone leading to firing tests of the Shuttle's main propulsion system. The Dec. 21 test assured that the main propulsion test article (the test facility and associated hardware) could handle super-cold propellants, liquid hydrogen, and liquid oxygen used by the Shuttle main engine. Propellants used to fill the external tank had flowed through connecting piping to the 3 engines until stopped by the main-engine valve; test engineers then made sure the engines had cooled down to operating temperature, several hundred degrees below zero. A series of static firings of the external tank, a simulated orbiter with a flight aft fuselage, three main engines, and associated piping would validate system operation. (*Marshall Star,* Jan 11/78, 4)

- A simulated Space Shuttle orbiter had represented the Enterprise during practice hoists into the tall tower where the latter would soon be tested, the *Marshall Star* reported. The real orbiter had recently completed a series of landing tests in Calif. and would next undergo a series of tests at MSFC to see how the orbiter and other Shuttle components would maintain guidance and control under vibration during launch and powered flight. MSFC engineers would use the simulated orbiter to rehearse tests; for example, they had towed the simulator along center roadways to check clearances. The team had then practiced hoisting the simulator into the 131m (430ft) test stand. After completing tests at MSFC, the simulator would go by barge to KSC to check out procedures for launch. Vandenberg AFB had asked to borrow the simulator for its Shuttle launch facilities. (*Marshall Star*, Jan 11/78, 1)

- Tass reported that the USSR launched *Soyuz 27* from Tyuratam on Jan. 10, 1978, at 7:26pm Moscow time to dock with the already occupied orbital station *Salyut 6*. Crewmen were Lt. Col. Vladimir Dzhanibekov, commander, and Oleg Makarov, civilian flight engineer. *Soyuz 26* had been docked with *Salyut 6* since Dec. 11, 1977; the 2 crews would carry out research and experiments on board. (FBIS, Tass in English, Jan 11/78)

January 12: ESA announced that the third (upper) stage of the heavy launcher Ariane, designed to use highly advanced liquid-hydrogen and liquid-oxygen propulsion techniques, had been successfully tested Jan. 10 at the Société Européenne de Propulsion's Vernon test center. The firing had lasted 250sec, as scheduled. With previous successful tests, this test had demonstrated European mastery of the technology, ESA said. ESA had developed Ariane to launch communications and other applications satellites weighing up to 1000kg into geostationary orbit 36 000km above the equator; ESA had plans to launch about 200 geostationary satellites between 1980 and 1990. (ESA Release Jan 12/78)

January 13: NASA announced that the National Remote Sensing Agency of India (NRSA) had agreed to build a ground station at Hyderabad in south central India to receive data directly from NASA earth resources satellites—*Landsat 2*, as well as Landsat C (scheduled for launch in March 1978) and Landsat D (scheduled for launch in 1981)—and to offer India and neighboring countries the practical benefits of remote-sensing technology. (NASA Release 78-6)

January 16: NASA announced it had selected 15 Space Shuttle pilot-astronaut candidates and 20 mission-specialist candidates as its eighth group of astronauts, including 6 women, 3 blacks, and an American of Japanese descent. The first women and minority astronauts could be in orbit within 3yrs. Selection criteria for the more than 8000 applicants had been motivation, educational background, and work experience. All but one of the 15 pilot candidates and 7 of the 20 mission-specialist candidates had come from the U.S. military services. Of the 35 selectees, 10 were from the Air Force, 9 from the Navy, and 1 each from the Marine Corps and the Army. The mission specialists selected had come from medical, biological, earth sciences, physical and chemical sciences, and engineering disciplines. The number of selections had been keyed to the expected need for Shuttle crews to supplement the 17 pilot and 10 scientist astronauts now on flight status in Houston. The new astronauts would begin 2 years of training July 1 at Johnson Space Center in Houston.

Selected to train as mission specialists were Anna Fisher, Shannon Lucid, Judith Resnick, Sally Ride, Margaret Seddon, Kathryn Sullivan, USAF Maj. Guion Bluford, USMC Capt. James Buchli, USAF Maj. John Fabian, Navy Lt. Dale Gardner, Terry Hart, Steven Hawley, Jeffrey Hoffman, Ronald McNair, USAF Capt. Richard Mullane, George Nelson, USAF Capt. Ellison Onizuka, Army Maj. Robert Stewart, Norman Thagard, James Van Hoften; as pilot astronauts, Navy Lt. Cdr. Daniel Brandenstein, Navy Lt. Cdr. Michael Coats, USAF Maj. Richard Covey, Navy lt. Cdr. John Creighton, Navy Lt. Robert Gibson, USAF Maj. Frederick Gregory, Stanley Griggs, Navy Cdr. Frederick Hauck, Navy Lt. Cdr. Jon McBride, USAF Capt. Steven Nagel, USAF Maj. Francis Scobee, USAF Capt. Brewster Shaw, Jr., USAF Capt. Loren Shriver, Navy Lt. Cdr. David Walker, and Navy Lt. Cdr. Donald Williams. (NASA press conference Jan 16/78; *Marshall Star*, Jan 17/78, 1; *W Star*, Jan 17/78, A-5; *AvWk*, Jan 23/78, 19)

• A NASA internal assessment chartered by the Carter Administration had found areas "where clearly there are too few people to do the job that needs to be done," reported *AvWk*. The study would aid in defining the proper size and structure of NASA through the early to mid-1980s, based on tasks assigned. NASA would continue to analyze its alternatives, including agency employment levels and the outlook on agency responsibilities. The resulting recommendations would be designed to accommodate a variety of funding levels. (*AvWk*, Jan 16/78, 21)

• FAA questions about isolation of hydraulic systems in the Anglo-French Concorde had delayed the plane's certification, *Aviation Week* reported. The British Aerospace Corp. had expressed confidence that the FAA would approve certification; an FAA team concluded earlier that 129 out of 149 certification items had complied with U.S. standards. Later, the engine had been certified, and cabin and crew compartments inspected. An FAA memorandum to the British noted questions on "the possibility of single-hydraulic system failure causing loss of all hydraulic systems, including flight control." The British and French would have to show that their fail-safe type of system provided a degree of safety

NASA
United States

First women to be named by NASA as astronaut candidates (left to right): Margaret R. (Rhea) Seddon, Anna L. Fisher, Judith A. Resnik, Shannon W. Lucid, Sally K. Ride, and Kathryn D. Sullivan. (NASA photo 78-H-81)

equivalent to that of the usual dual system, which observers expected them to do. (*AvWk*, Jan 16/78, 31)

• The Congressional battle over President Carter's efforts to delete funds for B-1 bomber aircraft 5 and 6 would resume after Congress reconvened in Jan., said *Aviation Week*. The outcome would depend on a Senate rescission move led by Sen. John Stennis (D-Miss.), chairman of the Senate Armed Services Committee, to uphold the administration's stand against B-1 funding. Last year the House had voted to oppose the Senate rescission stand after Senate-House conferees failed to resolve the issue. Senate B-1 proponents led by Sen. Alan Cranston (D-Calif.), Senate majority whip, had joined forces to sustain the House action and return the question to the conference. The administration might move quickly to win endorsement of the Stennis move to rescind while many senators were still away from Washington. (*AvWk*, Jan 16/78, 15)

January 17: The *Washington Post* reported that the U.S. and USSR had opened a more reliable "hotline" using satellites, instead of telephone wires and undersea cables, to link the White House and the Kremlin. The direct line had been available since 1963 for use in an international emergency. The direct link would use the synchronous-communications satellite Intelsat and the Soviet Molniya system of satellites. The previous hotline had been subject to unexpected interruptions, a potentially grave problem in event of tension between the two governments; it had been cut at least three times, once when a Finnish farmer cut a buried cable while cultivating land. (*W Post,* Jan 17/78, A-10)

January 18: The 16th Aerospace Sciences Meeting at MSFC of the American Institute of Aeronautics and Astronautics with nearly 700 registrants concluded with posthumous presentation of the space systems award to Dr. Werner von Braun, first MSFC director. Former astronaut Maj. Gen. Thomas Stafford had accepted the Haley spaceflight award on behalf of the Apollo-Soyuz Test Project crew. (*Marshall Star,* Jan 18/78, 1)

• MSFC announced that NASA had instituted a NASA End-to-End Data Systems (NEEDS) project to ease the enormous burden of storing data collected by its satellites and aircraft. NASA's public archives had been growing by 100 000 000 000 bits of data per day; during the 1980s and beyond, spacecraft like Spacelab, earth-orbiting satellites, and planetary probes would produce a staggering quantity of data, creating a major problem of storage and availability to users. NEEDS would decrease processing time and storage space, reduce maintenance costs, and provide better user access. Four field centers would participate in the project, MSFC being responsible for developing a medium to replace magnetic tape and microfilm. Working with Harris Corp. of Melbourne, Fla., MSFC had developed the optical mass memory system, using a dry-process film that could store as much data as on magnetic tapes or microfilm in 100 times less space, and could make access 100 times faster. The goal of NEEDS would be a tenfold reduction in the present $300-million-per-year storage/maintenance cost, and a thousandfold increase in information return to users. (*Marshall Star,* Jan 18/78, 4)

January 19: INTELSAT announced it had awarded Nippon Electric Co., Tokyo, Japan, a $175 000 contract for development of a multimode phase-shift-keying (PSK) modem for a nonlinear satellite channel. INTELSAT had established full-time global communications using 197 antennas at 161 earth stations in 87 countries. (INTELSAT Release 78-3-M)

January 20: NASA announced successful completion of the second full-duration ground-static firing of a huge solid-fuel rocket motor to be used in Space Shuttle flights beginning in 1979. Thiokol Corporation's Wasatch Division, prime contractor for MSFC development of the motor, had conducted the firing at Brigham City, Ut. The 125ft-long (38.1m) motor on the test fixture had fired for more than 2min, reaching a thrust level of 2832lb (12 596 736 newtons). The test firing had used 1 102 400lb (500 048kg) of propellants. The contractor had gimballed the motor nozzle early in the test and again later in the firing for about half the total burn time; the solid-fuel rocket booster's motor nozzles during Shuttle launches would provide directional control for the entire Shuttle assembly. MSFC had scheduled the next test for early summer. (MSFC Release 78-6; *Marshall Star,* Jan 25/78, 1)

• *Spaceport News* reported a spacecraft problem had delayed launch of FltSatCom-A, first of a new highly versatile 3-satellite military communications system in which each satellite in geosynchronous orbit would provide 23 operating channels. A FltSatCom (fleet satellite communications) system would provide reliable secure communications between naval units anywhere except in extreme polar regions, and would become part of the Air Force Satellite Communications System (AFSatCom) linking the national command authority with Strategic Air Command (SAC) and other USAF units. DOD had reserved one wideband 500KHz channel on FltSatCom-A. (*Spaceport News,* Jan 20/78,1)

January 21: NASA Administrator Robert Frosch in a briefing announced that NASA's FY79 budget would propose an 8% increase, providing "buying power" at about the 1978 level. The space science request had gone up about 27%, largely because of the Space Telescope and the Galileo (Jupiter-orbiter) project. Applications and aeronautics were each up about 16%. The proposed FY79 budget was $4.371 billion; the FY78 budget was $4.064 billion. The FY79 budget requested money for only four Space Shuttle orbiters; Frosch explained that the four orbiters would use two launch sites (KSC and Vandenberg AFB) and that NASA and the Air Force would phase out the existing stable of expendable boosters. Omitted was OV-101, the Enterprise, which would be used for approach and landing tests or for spare parts, or could be reconfigured in an emergency to spaceflight status.

The major new start NASA had included in the budget was the "Out of Ecliptic" (OOE) or Solar-Polar, a cooperative venture with ESA to fly two satellites to look at the structure of the sun's surface and at sunspots and poles. Other new starts NASA had requested were the HALO (halogen-occultation) experiments to study upper-atmosphere pollution, and the earth radiation-budget satellite system to study incoming and outgoing radiation. Key application continuations would be Landsat C and D, the Nimbus-G environmental satellite, Tiros-N next-generation weather satellite, and Seasat-A. Space Transportation Systems would receive $1 827 700 000; Space Science $513 200 000; Space and Terrestrial Applications $283 400 000; Aeronautics and Space Technology $375 400 000; Tracking and Data Acquisition $305 400 000. Manpower would remain at the FY78 level, with 45 positions shifted from MSFC to

JSC, KSC, and the Natl. Space Technology Laboratories. (NASA budget briefing, Jan 21/78; *Marshall Star,* Jan 25/78, 1; *W Star,* Jan 23/78, A-8; *AvWk,* Jan 23/78, 13; Jan 30/78, 28)

January 22: FBIS reported that, according to *Tass,* the automatic cargo-transport ship *Progress 1* launched Jan. 20 had docked with the manned scientific complex *Salyut 6/Soyuz 27* at 1:12pm Moscow time, first use of an automatic spaceship to supply fuel, equipment, and materials to a manned orbital station. The shipment would prolong considerably the functioning and effectiveness of manned orbital complexes. Linkup was to the docking gear in the instrumented compartment of the *Salyut 6* station. The mutual search, rendezvous, tethering, and linkup was automatic, using onboard radio-technical and computing devices. To increase cargo capacity and cut transportation costs, the USSR had designed *Progress 1* not to return to earth but to burn up on reentry. (FBIS, Tass in English, Jan 22/78)

January 23: NASA had formally designated as Project Galileo a 1982 mission to orbit a spacecraft around Jupiter for at least 20mo and send a probe into its atmosphere, NASA Administrator Robert Frosch announced. The designation had honored the 16th century Italian astronomer, first to observe Jupiter by telescope and discover its moons. Galileo would be the first planetary spacecraft carried by the Space Shuttle and the first planetary spacecraft named for a person, although NASA had christened the *Orbiting Astronomical Observatory 3 (OAO 3)* "Copernicus" after it was launched. (NASA Release 78-11)

- NASA announced it had retired *Landsat 1,* first spacecraft designed to discover and monitor earth's natural resources, on Jan. 16 after 5.5yr of operation in outer space. The multispectral scanner carried on *Landsat 1* had revolutionized earth observation from space. Launched in 1972 with a life expectancy of 1yr, *Landsat 1* had taken more than 300 000 pictures and had demonstrated remote-sensing applications in geology, oceanography, agriculture, forestry, hydrology, urban planning, crop prediction, and other disciplines. *Landsat 2,* launched in 1975, was still in orbit; a third Landsat would be launched in March. Three U.S. ground stations had received Landsat data, as had stations in Canada, Brazil, and Italy. Iran and Japan were building stations; Argentina planned one. (NASA Release 78-9; *Goddard News,* Jan-Feb 78, 5)

- *AvWk* reported that the third instead of the fifth Space Shuttle mission would attempt to raise the orbit of the abandoned Skylab space station, bettering chances of Skylab's remaining in orbit until the Shuttle could come to the rescue. NASA had scheduled the third Shuttle flight for Oct. 1979; the fifth, for Feb. 1980. A Martin Marietta teleoperator propulsion unit carried on the Shuttle to boost Skylab to a higher orbit would be left in space for retrieval by the fifth Shuttle flight. MSFC would build a solar panel for the teleoperator to keep it in orbit for as long as necessary. (*AvWk*, Jan 23/78, 22)

- The USSR had decided to keep a permanent manned space station in earth orbit as a result of the current *Salyut 6* space station mission, *AvWk* reported. Staffing this and follow-on Salyuts without major intervals between missions would be a milestone in manned spaceflight, and would demonstrate the USSR's decision to invest major resources in space.

The USSR had claimed the *Salyut 6/Soyuz 27* mission was more scientific than military; its activities had included photographing the Soviet Union to explore for natural resources, detailed medical studies of cosmonaut blood circulation, and upper-atmosphere and micrometeorite monitoring. The crew had also devoted more time to system checkout and monitoring, because the design of *Salyut 6* was a significant change from that of previous Salyut space stations.

The USSR had not previously flown a spacecraft configuration like *Salyut 6/Soyuz 26/Soyuz 27* to test the interaction of three large vehicles. It had tried various spacecraft attitudes to evaluate stresses during maneuvers on the docked system, and had transferred food and equipment from the *Soyuz 27* resupply vehicle and film, biological samples, and records to the *Soyuz 27*.

The Soyuz/Salyut mission had achieved three manned-spaceflight firsts: four-man space station, simultaneous docking of two transport spacecraft with an orbiting space station, and manned resupply of an occupied station. (*AvWk*, Jan 2/78, 20; Jan 9/78, 25; Jan 16/78, 20; Jan 23/78, 19)

- The National Oceanic and Atmospheric Administration (NOAA) announced it had awarded Eppley Laboratory, Inc., Newport, R.I., a $79 000 contract for specialized solar-tracking devices to measure solar radiation reaching earth, to extend its solar-radiation network. The Department of Energy had provided NOAA with funds for 50 pyrheliometers, one for each of NOAA's solar-radiation collecting facilities, to measure increased temperatures proportional to the intensity of incoming radiation. Architects, engineers, and others interested in solar-energy applications would use this information with other temperature, precipitation, and cloud cover data. (NOAA Release 78-8)

January 24: Tass announced that the USSR had launched a *Molniya 3* comsat carrying relay apparatus to operate in the centimeter waveband, into an orbit with 40 631km apogee in the northern hemisphere and 661km perigee in the southern hemisphere, period of 12hr 16min, and 62.8° inclination. The satellite would ensure operation of a long-distance telephone, telegraph, and radio-communications system, and program relay from USSR central television to points in the Orbita network. (FBIS, Tass in English, Jan 24/78)

January 25: NASA announced results of two November 1977 meetings with the USSR Academy of Sciences on further cooperation in space. An agreement reached in May 1977 focused on ways to benefit from the different attributes of Salyut and a reusable-Shuttle type of spacecraft. Dr. Noel Hinners, associate administrator for space science at NASA, had headed the U.S. delegation; Dr. Boris Petrov, chairman of the Intercosmos Council of the Soviet Academy of Sciences, had led the Soviet delegation. The groups had agreed to meet in the U.S. in late March or early April, in Moscow in July, and again in the U.S. in October.

The eighth annual meeting at Wallops Flight Center Nov. 19-25 of the NASA-Soviet Space Biology and Medicine Working Group had discussed biomedical findings: preliminary results of the Soviet *Cosmos 936* unmanned flight carrying U.S. experiments, and of the *Salyut 5/Soyuz 21* and *24* missions. The USSR had invited the U.S. to participate in Soviet biosatellite flights in 1980 and 1981. A workshop on simulated weightlessness held in Bethesda, Md., had preceded the meeting. Dr. David Winter, NASA director for life sciences, had headed the U.S. life sciences delegation and Dr. Rufus Hessberg, NASA director of space medicine, the workshop delegation. Soviet leader at both meetings was Dr. Nikolai Gurovsky of the USSR Ministry of Health. The ninth meeting would take place in the USSR in the second half of 1978. The workshop and meeting had been part of a program set up under a 1971 Science and Applications Agreement between NASA and the Soviet Academy of Sciences. (NASA Release 78-10)

- LeRC announced it had worked with Kresge Eye Institute in Detroit to reduce and regulate pressure inside the eye during glaucoma surgery using a device based on fluid-systems and components technology developed by NASA. The pressure-reduction system could mechanically lower intraocular pressure (inside the eye) to any level desired by the physician over a set time and in a controlled manner. A fluid supply with pressure matched to existing intraocular pressure would enter the anterior (front) chamber of the eye through a tiny tube inserted near the edge of the cornea; controlled reduction of fluid-supply pressure would reduce intraocular pressure by the same amount and at the same rate. The system would permit investigation and assistance in reduction of some post-eye surgery complications such as cataract formation, vascular-membrane detachment, flat anterior chamber, and malignant glaucoma. NASA planned to continue development of the device under controlled clinical conditions. (NASA Release 78-12)

- MSFC announced plans for two runs by a high-speed sled in Feb. at the Sandia sled track, Albuquerque, N.M., to test the "broadside deployment phase" of the Space Shuttle's solid-fuel rocket booster parachute-recovery system. The sled tests would deploy only the pilot chute to determine if the nosecap when ejected would clear the vehicle without becoming entangled, as boosters would come in flat, not sideways like an arrow, and air would flow across the nose cone at right angles. MSFC had developed the SRB and its recovery system. (*Marshall Star*, Jan 25/78, 4)

- INTELSAT announced appointment of 3 deputy directors and 4 division directors. New deputy director generals were Andrea Caruso, administration; Reginald Westlake, finance; and H. William Wood (former NASA deputy associate administrator for networks, OSTDS), operations and development. New division directors were Francis Latapie, procurement; Emeric Podraczky, engineering; William Geddes, operations; and NandKishore Chitre, systems planning. After INTELSAT's contract with ComSatCorp for management services expired in Feb., INTELSAT would assume responsibility for all technical, operational, and procurement functions previously performed by ComSatCorp, which would continue to provide certain technical tasks under two service contracts. (INTELSAT Release 78-4-I)

January 26: NASA announced it had launched the International Ultraviolet Explorer (IUE) from KSC at 12:36pm EST on Jan. 26, 1978, aboard a Delta rocket. KSC had delayed the launch for 4hr to secure an access door on the Delta heatshield. The Delta had injected IUE into a transfer orbit with 46 342km (28 784mi) apogee, 167km (104mi) perigee, and 28.7° inclination. IUE was part of a joint program by NASA, ESA, and the United Kingdom's Science Research Council (SRC); more astronomers (200 from 17 countries) would use IUE than had used any previous satellite. The satellite's telescope, aimed by ground controllers, would examine the ultraviolet spectrum between 1 150 and 3 200A, a region inaccessible to study from the ground.

Studies would range from planets in earth's solar system to some of the most distant objects in the universe, including quasars, pulsars, and black holes in space. Astronomers would study a wide range of stars to learn how they were born, live, and die; the material between these stars from which they are formed and are still forming; strange objects emitting radio waves or x-rays, or both; the sedate nearby galaxies and the violent distant quasars; and earth's planetary neighbors and their satellites. IUE would complement and extend current NASA observations from the two orbiting astronomical observatories, *OAO 2* and Copernicus, and ESA's *TD 1* satellite. IUE's follow-on would be the 10-ton Space Telescope (ST) to be launched by the Shuttle in 1983.

The IUE spacecraft was an octagonal cylinder approximately 1.5m tall and 1.3m between opposing faces. Overall length of 4.2m included a telescope tube at the forward end and an apogee motor extending from the rear. Solar arrays on opposite sides of the spacecraft when unfolded in space would measure 4.3m (14ft) wide. Spacecraft weight was 1479lb, of which 272lb was scientific instrumentation. After stabilization, the spacecraft would continuously point one of its two solar arrays at the sun.

Goddard Space Flight Center would have a constant view of IUE; ESA's Villafranca station near Madrid, Spain, a view at least 10hr per day. GSFC had designed, integrated, and tested IUE and provided U.S. ground-support facilities; ESA had built the solar array and the Madrid ground facilities. SRC, in collaboration with Univ. College, London, had provided four television camera detectors to transform spectral displays into video signals for transmission to the ground. The joint agreement had allocated 16hr of viewing time a day to NASA, 8hr to be shared jointly by ESA and the United Kingdom. The U.S. had spent $57 million on the spacecraft, Delta rocket, and other items; ESA had spent $21 million; SRC and Univ. College had spent $9 million. (NASA Release 78-8; MOR S-868-78-01 [prelaunch] Jan 19/78, [postlaunch] Feb 2/78; *NYT*, Jan 27/78, A-8; ESA Release Jan 20/78; *Goddard News*, Jan-Feb 78, 1)

- NASA announced it would celebrate Jan. 31 the 20th anniversary of the first U.S. artificial earth satellite, *Explorer 1*, which had ushered the western world into the space age. Principal scientific achievement had been discovery of the Van Allen radiation belts surrounding the earth. Weighing 13.9kg (30.8lb), measuring 15.2cm (6in) in diameter and 203.2cm (80in) long, and shaped like a stovepipe, *Explorer 1* had been the product of two other organizations now elements of NASA: the development group of the Army Ballistic Missile Agency (ABMA) at Huntsville, Ala., and the Jet Propulsion Laboratory (JPL) of CalTech at Pasadena, Calif. In 1960 ABMA had become the nucleus of MSFC; JPL had gone under contract to NASA in Dec. 1958. ABMA had provided the modified Redstone booster and the basic satellite design, and JPL had furnished the solid-propellant upper stages of the carrier vehicle and had packaged and tested the payload.

Explorer 1's launch from Cape Canaveral, Fla., on a Jupiter C vehicle at 10:48pm EST, Jan. 31, 1958, had come 45 days after DOD had given the Army the go-ahead to prepare a backup to the existing U.S. Navy Vanguard project. *Explorer 1* had continued to transmit information on the space environment until May 23, 1958, when its batteries were exhausted; it had reentered March 31, 1970. Dr. James Van Allen had designed the scientific package that discovered the radiation belts named for him. The *Explorer 1* launch had been part of U.S. participation in the International Geophysical Year. (NASA Release 78-13; MSFC Release 78-9; JPL Release Jan 27/78; NRC *News Report*, Feb. 78, 1; *Spaceport News*, Jan 9/78, 2; Jan 20/78, 3; *JPL Universe*, Jan 20/78, 1; *Marshall Star*, Jan 25/78, 2)

• Although the U.S. and USSR had signed separate treaties in 1963 and 1967 prohibiting test and deployment of nuclear weapons in space, western observers had interpreted the USSR's Cosmos series as an antisatellite development program, Farooq Hussain reported in a *Nature* article. Killer satellites had exploited the poor resistance of satellite components (particularly solar cells) to intense heating and radiation damage; they could aim at satellites' high energy-lasers or ion beams to cause arcing and discharge through instrumentation. Precision-guided missiles could destroy satellites either by colliding with them or by detonating conventional explosives close to a target. One explanation of recent Soviet tests had been China's development of reconnaissance satellites. The only U.S. test of an antisatellite had occurred in 1963 when a modified McDonnell Douglas Thor missile had been fired against a missile booster in low earth orbit.

Recent advances had indicated that killer satellites might carry high-energy continuous-wave or pulsed lasers to destroy target satellites; both sides had used ground-based lasers for several years to interrogate reconnaissance satellites. In Sept. 1977 the Air Force had awarded to Vought Corp., Dallas, Tex., a $58.7 million contract for development of a killer satellite. To avoid the cost of this arms race, the article said, both the U.S. and USSR had been willing to agree on limiting development of killer satellites. (*Nature*, Jan 26/78, 293)

January 27: NASA announced that scientists from NASA's Ames Research Center and NOAA's Environmental Research Laboratory in Boulder, Colo., had begun flight tests of an instrument designed by NOAA scientist Dr. Peter Kuhn to warn pilots of impending turbulence (see *A&A 1976*, Nov. 11, 277). Dr. Kuhn, an experimenter on NASA's Gerard P. Kuiper Observatory (a C-141 aircraft equipped with a large telescope for astronomy research), had noticed that variations in atmospheric water vapor as measured by an infrared (IR) water-vapor radiometer had often accompanied extreme turbulence encountered by the aircraft; he had succeeded in using IR radiometer to define atmospheric conditions in the telescope's field of vision. Dr. Kuhn then suggested mounting an IR radiometer aimed forward in an aircraft; this system had successfully predicted occurrences of turbulence in clear air from 2.5 to 5.5min before encounter. However, researchers needed more encounters from various directions and altitudes to test the instrument, and wanted to experiment with filters and to fine-tune the instrument for optimum results.

The joint NASA-NOAA program would consist of exhaustive tests using a NASA Learjet research aircraft to develop a low-cost system that would enhance flight safety and comfort, be suitable for any aircraft, be able to operate unattended and require minimum maintenance, and produce a cockpit visual alert 4 to 5min before a turbulence encounter. (NASA Release 78-15)

• LaRC reported on its Jan. 17-19 seminar on Large Space Systems Technology (LSST) attended by more than 200 persons who had exchanged ideas on the technology needed to build large space systems in the future. The group had tried to guess what research and technology the multimission needs of the Space Shuttle would be in 1985 to 2000; NASA had scheduled no definite programs for 1985 to 2000, but wanted to ensure performance of economical and well-organized future missions.

Seminar subjects included predictions of structural behavior in space, particularly under loads and stresses; advanced materials and techniques for joining various kinds of structures; distribution of controls for large structures; and electronics equipment needed for operation and control of structures. Those attending had represented six NASA centers, 24 aerospace firms, 8 universities, and 4 DOD centers. To continue cooperation between government agencies and industry, LaRC planned to hold a similar seminar yearly. (LaRC Release 78-3; *Langley News*, Jan. 27/78, 1)

January 28: A Canadian Air Force transport searching for radioactive contamination from a Soviet satellite that disintegrated over northwest Canada had reported a "highly probable" radiation contact, the *W. Star* reported, first to be discovered since Jan. 24 when the crippled *Cosmos 954* satellite powered by a nuclear reactor containing 100lb of highly radioactive uranium 235 had reentered earth's atmosphere. The occurrence had sparked controversy over hazards of radioactive space debris; the U.S. space program had used radioisotope power systems, but had launched only one fission reactor, that on the *Snap 10A* test vehicle. Fission reactors such as that on *Cosmos 954* would create strontium, cesium, and cerium byproducts potentially lethal if radiation dosages were high or prolonged.

The USSR had launched at least 10 reactors on spacecraft like *Cosmos 954*, 16 with the same operating parameters having flown since Dec. 27, 1967; it had put all the reactor craft except *Cosmos 954* in safe high orbit. The Soviet and U.S. governments had kept close contact during the incident. National Security Affairs Assistant Zbigniew Brzezinski, quoted by TASS, said, "I would like to point out two things: first that this incident which, to my mind, is nothing out of the ordinary in the space age, is fully controlled so we believe there is no danger. . . . Second, that the governments of the U.S., the Soviet Union, and other governments concerned cooperated intensively concerning this matter." (FBIS, Tass in English, Jan 25/78, Jan 28/78; *W Star*, Jan 26/78, A-1; *AvWk*, Jan 30/78, 33; *Economist*, Jan 28/78, 75)

• NASA announced that it had appointed Dr. John McCarthy director of LeRC, effective Oct. 1, 1978. Currently director of Massachusetts Institute of Technology's Center for Space Research and a professor of aeronautics and astronautics, Dr. McCarthy had been widely recognized as an expert in systems engineering and vehicle design. He had served as a member of the Air Force Scientific Advisory Board and chairman of the Aeronautical Systems Division Advisory Group, Air Force Systems Command, and had been a member of the Joint Strategic Target Planning Staff Scientific Advisory Group for the Joint Chiefs of Staff. (NASA Release 78-16)

January 30: FBIS reported that the People's Republic of China had launched on Jan. 26 an earth satellite that had functioned normally in orbit and returned to earth "after fulfilling tasks of scientific experimentation." The report added that the achievement had resulted from the guidance of the wise leader Chairman Hua Kuo-feng. (FBIS, Tass in English, Jan 30/78)

• Thiokol Corp.'s Wasatch Div. had used an airfilm material-handling system at its Brigham City, Utah, plant to move and position Space Shuttle solid-fuel rocket-motor components weighing up to 300 000lb, *AvWk* reported. The size of components for the Shuttle's solid-fuel rocket motors and the large number of Shuttle missions expected had led Thiokol to try new types of material-handling systems.

Heaviest load moved had been a solid-fuel rocket-motor casting segment loaded with propellant weighing about 300 000lb on a transporter dolly weighing an additional 50 000lb, for a combined total of about 175 tons moved. (The motor would consist of four segments individually cast with solid rocket motor fuel in one of several pits at the Thiokol facility.) The airfilm system used compressed air to inflate urethane pads (bearings) attached to the bottom of specially-designed dollies; air forced into the bearings and seeping between them and the floor had created a space of two or three hundredths of an inch—enough to "float" the transporter and its load on a film of air. (*AvWk*, Jan 30/78, 56)

January 31: ESA announced that it had successfully tested the second stage of its Ariane launcher in flight configuration, at the Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt e.V. test center in Hardthausen, Germany. The 138sec test had checked compatibility between the structure (fuel tanks) and propulsion system (engines) and that of the pressurization system, propulsion-system performance, and structure resistance. ESA had scheduled two further tests in the next few weeks; all three stages of the launcher had reached complete-stage testing. The Centre National d'Études Spatiales, France, had developed Ariane for ESA; more than 50 firms in 10 ESA-member countries had participated in the program. (ESA Release Jan 31/78)

- Federal Aviation Administrator Langhorne Bond said the British Civil Aviation Authority and the British Plessey Corporation had been "using the press and other news media to deliberately mislead and confuse the world aviation community" about a U.S.-backed all-weather approach and landing system. The FAA administrator said the time reference scanning-beam/microwave landing system (TRSB/MLS) had been developed in a "goldfish bowl" from the outset with wide public participation; he labelled as "simply not true" British allegations that the U.S. had conducted a misleading test program or issued false data, and that the TRSB system was unsafe. Bond said the International Civil Aviation Organization (ICAO), at its worldwide meeting in April, would probably select TRSB as the international system and that the campaign to discredit TRSB had been a last-minute effort by the British and Plessey to influence ICAO's decision. (FAA Release 9-78; *W Star*, Jan 7/78, A-1)

During January: NASA announced it had tentatively selected 18 scientists to participate in the design and early operational phases of the Space Telescope project. The 10-ton observatory to be launched by the Space Shuttle in 1983 would make astronomical observations deeper into space and in more detail than ever before. The scientists would head teams representing investigations definition (design and develop the focal plane instruments and carry out major scientific investigations); astrometry science (ensure that a fine guidance system could perform the required astrometric functions); faint-object camera science (U.S. members to assist ESA's team); telescope science (interpret performance requirements in terms of telescope design specifications); data and operations (establish instrument specifications for control system, flight operation, and ground data handling); and interdisciplinary science (provide a broad scientific overview of ST development). A Space Telescope science working group to give scientific guidance to the project would consist of team leaders, 2 telescope scientists, interdisciplinary scientists, and appropriate project personnel. MSFC had management responsibility for the telescope; GSFC would manage operations and the development of scientific instruments. *(NASA Activities,* Jan 78, 9)

• NASA announced it would hold a symposium Jan. 16 and 17 in Washington, D.C., on the proper role NASA should be prepared to fulfill during the early to mid-1980s. The symposium would host 20 nationally-known authorities in fields including federal research policy, economics, education, science, aircraft development, and space applications. The symposium was a part of its current assessment of its institutional base. (NASA Release 78-5)

• NASA reported that DOD had lent it 5 Navy divers to support simulated weightlessness tests in the Space Shuttle program. The divers, all fleet-salvage men selected for their expertise in erecting or dismantling underwater structures or equipment, had been assigned to the neutral buoyancy simulator at MSFC. Working underwater in full-scale segments of the Space Shuttle, they would assist test engineers with contingency procedures, equipment operation, evaluation of space-construction techniques, and other activities scheduled for Shuttle and Spacelab missions. (*NASA Activities,* Jan 78, 5)

• GSFC reported that, as a result of its concern about possible volcano damage to a Spaceflight Tracking and Data Network (STDN) station, Mt. Cotopaxi in Ecuador, tallest volcano in the world, almost 6km (3.75mi) high, had been transmitting continuous information on its seismic activity. Dr. Richard Allenby of the Geophysics Branch at GSFC had installed a geophysical monitoring system consisting of a single-axis vertical seismometer and two tiltmeters. The system had transmitted data to the STDN station for quick review and relay for analysis to Dr. Minard Hall, geology professor at Ecuador's Escuela Politecnia National. Any unusual volcanic activity identified by Hall would be immediately relayed back to the station and to the Ecuadorian authorities.

The seismometer and its preamplifier, the only permanent volcano-monitoring system in South America, had been encased in a sealed plastic tube and buried about a meter (3ft) underground for fear of an eruption within the next few years. Other remaining field instruments and batteries had been buried in 50-gal oil drums. Although the equipment had not detected major volcanic activity, it had detected ground motions along a nearby active fault line. (*Goddard News*, Jan/Feb 78, 4)

• MSFC had issued to industry a request for proposals to study an automated longwall guidance and control system for coal mining and to build a prototype, *NASA Activities* reported. Studies by MSFC engineers over the past 2 yrs had indicated the potential practicality of a system using gamma rays, radar beams, impact devices, or reflected light to guide a longwall shear's cutting edge. The engineers had applied automated guidance and control-system technology developed for the lunar roving vehicle to a "longwall machine" that would grind coal from a wall or face of a coal seam in a more or less straight line, send it out on a conveyor, and advance with mechanized roof supports. Automating such a machine could eliminate the need for humans to work next to the cutting operation. Automated guidance and control would permit much faster removal of virtually all the coal present, increasing annual production by millions of tons of purer coal. The automated system should reduce wear on cutters and minimize machine downtime. (*NASA Activities*, Jan 78, 9)

• The Air Force Systems Command reported it had successfully concluded a 2-yr space-communications test program 4mo ahead of schedule, saving the Air Force more than $500 000. Directed by the Satellite Communications Terminal Program Office, SAMTEC's 6555th Aerospace Test Group had launched the Lincoln experimental satellites *LES 8* and *9* from Cape Canaveral 22 000mi into space to demonstrate advanced technology that would provide dependable jam-proof communications between satellites spaced thousands of miles apart and terminals scattered over more than 75% of the earth's surface. The satellites and terminals had worked essentially flawlessly.

In the test, a receiver and transmitter on each satellite had relayed messages for the first time directly between two spacecraft without ground or airborne relay. Acting as earth-orbiting relay stations during the test program, the satellites exchanged voice and data information between airborne, ground, and shipboard terminals. Instead of batteries charged by solar panels (susceptible to radiation damage), each satellite had used two nuclear-powered thermal generators for long-term dependable power services. Some tests had run continuously for 2 or 3 days, requiring 24-hr manning. Nerve center for the program had been the test-management facility at the Mitre Corp., Bedford, Mass. (ASFC *Newsreview*, Jan 78, 6)

• NASA announced personnel changes at Hq.

—Herbert Rowe, acting deputy associate administrator for external relations, would leave to become vice president of the Electronic Industries Association. Rowe had joined NASA in 1975.

—NASA had appointed Frank Penaranda director of the institutional Operations Division, Office of Management Operations, effective immediately. He would be responsible for managing the agency's R&PM budget and institutional management system, including program support negotiations between centers and program offices, coordinating agencywide civil service and contractor manpower planning, and overseeing the center's aircraft operations.

—NASA had appointed C. Ronald Hovell director of the Resource Management/Administration Office, Office of Space Transportation Systems. He would be responsible for budget and control support of each STS program directorate having responsibility for STS funds.

—Effective Jan. 1, Dr. S. Ichtiaque Rasool had become chief scientist in the Office of Space and Terrestrial Applications. Rasool had maintained an active relationship with academic, industrial, and government organizations working on development and use of scientific and technological instrumentation, theory, and techniques for study earth and its nearby space environment. (NASA anno Jan 11, 16, 20, 30/78)

February

February 1: Fifteen scientists who would manage earth-orbital investigations for the third Spacelab in mid-1981 had met at Marshall Space Flight Center to discuss preparations for the mission, the *Marshall Star* reported. Known as the investigators' working group for Spacelab mission 3 (IWG-3), the group would work with NASA mission management to develop a payload offering the greatest possible scientific return and to select payload specialists who would perform experiments aboard Spacelab 3. Those at the meeting agreed on professional qualifications for payload specialists and on criteria for their selection, beginning in the second half of 1978.

Sponsored by the NASA Hq Office of Space and Terrestrial Applications, Spacelab mission 3 would include materials processing in space, the atmospheric cloud-physics laboratory, the drop-dynamics module, and vestibular-function research. Experiments would obtain basic knowledge about crystal-growing processes in earth orbit, mechanisms for generating small latex spheres, dynamic behavior of free-floating drops of liquid, cloud formation in the atmosphere, red blood cell aggregation, and adaptation of life forms to space. MSFC would manage integration and operation of the scientific payloads flown on the first 3 Spacelab missions. (*Marshall Star*, Feb 1/78, 1)

• MSFC reported that the USAF had redesignated an interim upper stage (IUS) for Space Shuttle as the "inertial upper stage," to reflect its inertial-guidance capabilities as compared to the NASA-sponsored spinning solid upper stage. The new name would also indicate that DOD payloads would use the stage well into the 1980s. (*Marshall Star*, Feb 1/78, 1; *Spaceport News*, Feb 17/78, 3)

February 2: NASA announced plans to launch on Feb. 9, 1978, the first spacecraft in a new worldwide military communications system. DOD's Fleet Satellite Communications (FltSatCom) satellites would provide vital communications for the Navy, Air Force, DOD, and the Presidential Command Network [see Jan. 20]. The spacecraft would go into synchronous-transfer orbit on an Atlas Centaur from ETR's launch complex 36.

FltSatCom, a highly versatile military-communications system built by TRW Defense and Space Systems, would offer 23 operating channels:

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the Navy would use 1 fleet-broadcast and 9 fleet-relay channels for communications between naval aircraft, ships, submarines, and ground stations, ship-to-ship and ship-to-shore. The system could offer reliable secure communications between naval units, even relatively small vessels equipped with inexpensive antennas and simple equipment, anywhere in the world except in extreme polar regions. The Air Force would use 12 narrowband channels as a part of the Air Force Satellite Communications System (AfSatCom) linking the national command authority with Strategic Air Command (SAC) units and other arms of the Air Force; DOD had reserved 1 channel. The Naval Electronic Systems Command would manage the FltSatCom program.

The spacecraft would consist of two major hexagonal elements (a payload module and a spacecraft module), with the majority of electronic equipment mounted on 12 panels enclosing the payload and spacecraft modules. The payload module would contain UHF and X-band communications equipment, and antennas—the UHF-transmit antenna, built of ribs and mesh to open like an umbrella; and the receive antenna, a separate deployable helix. The spacecraft module would contain earth sensors, an apogee kick motor, attitude and velocity control, telemetry tracking and command, electrical-power distribution, and a solar array folded around the spacecraft module until reaching final position in orbit, to be deployed by spring-loaded hinges. The 1875kg (4132lb) spacecraft weighed about 390kg (860lb), more than any satellite previously launched into synchronous orbit on an Atlas Centaur, NASA's standard launch vehicle for intermediate-weight payloads. (NASA Release 78-17; MOR M-491-202-78-01 [prelaunch], Feb 3/78)

- Former NASA Administrator Dr. James C. Fletcher received NASA's Distinguished Service Medal at a ceremony at NASA Hq on Jan. 30, 1978. Dr. Frank Press, President Carter's science adviser, made the presentation in recognition of Dr. Fletcher's "distinguished leadership . . . outstanding scientific and administrative abilities . . . and contribution to the nation's significant achievements in the exploration of space and utilization of space to manage the earth's resources." Dr. Press noted, "His decision to proceed with the development of the Shuttle orbiter exemplified the perceptive leadership which foresaw space as a giant laboratory where men will work to improve the future of all mankind." Dr. Fletcher, who was NASA administrator from April 27, 1971 until May 1, 1977, was a consulting engineer and vice president of the National Space Institute in Washington, D.C. (NASA Release 78-18, *Langley Researcher*, Feb 24/78, 1)

- A detailed article on manned spaceflight in a recent Chinese technical journal had raised speculation that the People's Republic of China might attempt to put a man in orbit, reported FBIS. *Navigation Knowledge*, published by the China Navigation Society, had printed a description of manned-flight problems such as weightlessness and satellite design, the effects of weightlessness on the body, and the growing of food in outer space. The article suggested that the PRC, having retrieved three unmanned satellites from orbit, was now ready to experiment with living in space.

Much of the article concerned physical changes resulting from a space-capsule environment, and the food, clothes, and waste facilities appropriate for an astronaut, information apparently based on completed experiments. By using the direct rays of the sun, the article claimed, a space voyager could grow rice and wheat the size of a Chinese date tree and eggplant and peppers the size of watermelon. Observers believed Chinese space technology had developed considerably since the initial space launches and that the next (No. 8) launch might have an animal aboard. (FBIS, Kyodo in English, Feb. 2/78)

February 3: Kennedy Space Center reported it had begun a 3-mo exercise called Spacelab Critical Design Review, whose results would go to a final board meeting on design changes needed for Spacelab to fly. ESA's prime contractor, ERNO, had assembled Spacelab data consisting of 34 volumes and approximately 3000 drawings and had packaged 5 sets, weighing a total of 500lb, for shipment to the U.S. KSC review groups would look for discrepancies to ensure that the data reflected the hardware design and that the design was compatible with KSC operations. The reviewers would submit any discrepancies to a screening group, which would select those to be forwarded (along with those identified by other NASA centers) to MSFC for consolidation and decision on which would be sent to Europe. Those finally selected would be consolidated with ESA-identified discrepancies and forwarded to ERNO. *(Spaceport News,* Feb 3/78, 1)

- John Pierce of the CalTech department of electrical engineering wrote in a *Science* magazine editorial that space exploration and technology had been remarkably rewarding by any standards, because the American public and government had been willing to try new and promising things without any guarantee of success. "Some areas of space," he said, "appear to be reserved perpetually for our government or competing governments. We must continually spend government money to ensure that our launch capabilities keep ahead of those of the rest of the world. Without this, even the most lucrative uses of space will pass into other hands." He advocated continued funding for planetary exploration and other radically new space science, even without immediate financial return: "If space science, including planetary exploration, is not adequately funded, we will lose an art which, having led us to glory, may lead us much farther. A future without adequate support in this area of great national success would be dismal indeed." (*Sci*, Feb 3/78, 4328)

February 4: FBIS reported that the Japanese Defense Agency had deciphered the "identification, friend or foe" (IFF) code of the Soviet MiG-25 flown by a defecting pilot to Japan's Hakodate airport in Sept. 1976. IFF, a top-secret device, would enable a pilot flying at Mach 2 to identify a plane appearing on a radar screen. At that speed, since identification could not be made by sight, the pilot would send an electric wave in cipher; a plane that failed to return a prearranged signal would be attacked. The decoding was the result of intensive study of data observed from the MiG-25. Western military experts had discovered the Soviet approach to constructing secret codes, the basic units of pulse signals emitted by the IFF, and the sequence of Soviet codes. The USSR would now have to revise all IFF codes for the MiG series, including 300 MiG-25s and 115 MiG-25Bs. One aviation expert noted that the IFF had provided vital information; ". . . it is not an overstatement to say that the IFF was the only secret about the MiG-25 that landed at Hakodate." Japanese and U.S. authorities had returned the MiG to the USSR after study. (FBIS, Kyodo in English, Feb 4/78)

February 6: NASA announced it had appointed Dr. John Klineberg deputy associate administrator in the Office of Aeronautics and Space Technology (OAST), where he would be responsible under the OAST associate administrator for general management and direction of OAST programs. Klineberg had come to Ames Research Center in 1970 from CalTech; while at ARC, he had done fundamental research on transonic flow, particularly on viscous effects and boundary-layer separation. After joining the OAST Aerodynamics and Vehicle Systems Division at Hq in 1974, Klineberg had managed aeronautics research on short- and reduced-takeoff-and-landing (STOL), vertical-takeoff-and-landing (VTOL), and rotorcraft vehicles. Appointed in 1976 to the OAST Aircraft Energy Efficiency Office, he had been responsible for aerodynamics and active-controls elements of that program. (NASA anno Feb 6/78)

- *Av Wk* reported that the Carter administration had planned an intensive $400- to $500-million program of killer satellite technology to overcome the USSR's 10-yr lead. The USAF Flight Test Center at Edwards AFB, Calif., announced it had sought proposals for an air-launched space booster usable in an antisatellite program. Vought Corp. had undertaken work on killer-satellite technology under a $58.7-million contract. Such a non-nuclear warhead system could consist of small rocket tubes clustered around an optical-sensor package containing a small digital computer;

this device would use the rocket-propulsion tubes as the kill mechanism. In the antiballistic-missile mode, a warhead's terminal homing device would detect the target, and the computer would govern maneuvers by firing the tube-mounted rockets. Once the device approached within range of the target, the rocket tubes would separate and fire into the path of the object, destroying it.

President Carter revealed that the U.S., in addition to the "hot-metal" kill mechanism, had been working on lasers as possible spaceborne defense against Soviet killer-satellite attacks. At the same time the USSR had pushed forward with laser-equipped killer-satellite systems, the U.S. had jeopardized its negotiating position in upcoming killer-satellite limitation talks by failing to convene a cabinet-level interagency group to decide between State Dept. and DOD negotiating strategies, marked by differences in opinion on verification and on impact on U.S. systems proposals. (*AvWk*, Feb 6/78, 18)

• *Av Wk* reported that the Research Ministry of the Federal Republic of Germany had sent NASA a financial deposit to reserve space on Spacelab flights in 1981 and 1982. ESA, also interested in space on two near-term flights, had not yet made the small deposit required for inclusion in mission planning. FRG also had placed an order with NASA for space on the Shuttle for 25 "getaway special" small payloads, most of them space-processing experiments that would lead to larger processing activities on later Shuttle/Spacelab missions. (*AvWk*, Feb 6/78, 15; Feb 27/78, 13)

February 8: MSFC announced that its Boeing 747 modified for Shuttle-orbiter transport had arrived at Redstone Army Airfield in Fla. for a dry run in preparation for its March landing with an orbiter atop. Crews from MSFC, KSC, and Dryden Flight Research Center had checked out handling gear and procedures to be used at MSFC for receiving the orbiter and offloading it from its carrier. MSFC had installed a large lifting derrick at the airfield with lateral-restraint and other devices needed to lift the Enterprise clear of the 747 and position it on a trailer-like transporter. When the 747 had departed, handling crews at the airfield would continue verification of the mate-demate device, using the orbiter ground transporter and a full-size orbiter simulator. (*Marshall Star,* Feb 8/78, 1)

• Tass announced that the automatic supply-transport ship *Progress 1* had reentered and burned in the atmosphere Feb. 8. The vehicle had a mass of 7020kg and could carry into orbit 2300kg of equipment, materials, fuel, and gas. Principal new features of *Progress 1* had been the refueling system and a means of carrying an increased air supply. Its automatic operation on command from either the ground or from the orbiting Salyut had been without precedent in spaceflight. *Progress 1* had also recorded dynamic characteristics of the *Salyut 6/Soyuz 27/Progress 1* complex and had corrected the station's orbit. (FBIS, Tass in English, Feb 8/78; Feb 6/78)

February 9: Dr. Frank Press, director of the White House Office of Science and Technology Policy, had launched a campaign to reduce paperwork required by the government from university scientists receiving federal support, *Nature* reported. Press said money saved in this way might mean millions of dollars for every university, and wrote to NASA and NSF asking what steps they could take to reduce paperwork and to streamline grants regulations. Press added that, although there was little support in the administration for a Dept. of Science, interest was growing in establishing a Dept. of Technology and Industrial Development. (*Nature*, Feb 9/78, 497)

February 10: NASA announced it had selected Fairchild Space and Electronics Co., Germantown, Md., to negotiate a fixed-price incentive contract for integrating, testing, and delivering 2 multimission modular spacecraft (MMS) for Landsat-D at a target cost of about $10.3 million. The MMSs would serve as basic spacecraft buses for the Landsat-D mission and a backup.

Under the contract managed by GSFC, Fairchild would integrate and test the spacecraft buses; design and test the propulsion module; fabricate and test a signal-conditioning and control unit; fabricate a spacecraft structure; design and fabricate a spacecraft harness for the thermal and electrical systems; acquire ground-support systems and a simulator for spacecraft integration and testing, and for delivery to spacecraft users; integrate these elements with 3 government-furnished subsystem modules (power, communications and data-handling, and attitude-control subsystems); test the integrated systems; and provide 24 man-months of instrument support. The contract would include options for integrating and testing up to 4 additional MSSs for future programs through approximately 1982. (NASA Release 78-21)

• NASA announced plans to develop hardware systems to support materials-processing experiments aboard the Space Shuttle in mid-1981. The materials-processing in space (MPS) program would take advantage of near-weightlessness in earth orbit to eliminate sedimentation in liquid materials and to reduce movement of liquid caused by heat, allowing precise control of processes such as casting and crystal growth.

MSFC had asked industry to submit proposals by Feb. 23 for support of 8 materials-processing experiments on 1981 Shuttle/Spacelab missions, specifically a fluids-experiments system and a solidification-experiments system using a high-temperature furnace; other hardware systems to be developed would support individual experiments and related earth-based systems. The fluid-experiments system would use an area in the Spacelab for optical observation of fluid phenomena; it would accommodate a variety of cells for use in a broad range of experiments. The solidification experiments system would require a multiuse system for processing metals, alloys, eutectics, semiconductors, crystals, ceramics, glasses, etc., in orbit by melting, refining, and resolidification in near weightlessness. Scientists at MSFC's ground control laboratory would process "control samples" under conditions identical (except for gravity) to those on the spacecraft. (MSFC Release 78-20; *Marshall Star*, Feb 22/78, 2)

• To alleviate natural gas shortages and other disruptions caused by unusually harsh weather, the U.S. government would increase efforts to understand and predict seasonal variations in climate by starting a national program on climate research described in President Carter's budget proposals for 1979, *Science* magazine reported. Climate research was not new: the Depts. of Defense, Commerce, Agriculture, Energy, and Interior, as well as NASA, EPA, and NSF, would spend $76 million on it in 1978. Next year, however, would be the first time a single agency – NOAA – would coordinate all research under a national plan. Cost of climate research would rise 37%, to $104 million in FY79.

NOAA's Climate Program Plan would use a fourfold approach: assessment of the relationship between climate variations and national activities through studies of carbon dioxide, crop yields, land and water resources, and coal use; early warnings of short-term climate fluctuations through a variety of observation systems; better understanding of climate processes through research carried out on the oceans and in the atmosphere; and study from space of long-term climate variations by monitoring subsurface ocean temperatures and snow levels. NOAA would not have authority to approve or reject any agency's climate-program proposals, but could consolidate them into a single budget proposal for review by the White House each yr. (*Sci*, Feb 10/78, 671)

February 12: Space station *Salyut 6* would complete a thousand orbits on this date, Tass announced. During the day, cosmonauts Yuri Romanenko and Georgy Grechko had installed and switched into operation a new life-support-system air filter delivered by *Progress 1*. Of great interest to Soviet scientists were the crew's regular reports on natural calamities: dust storms, forest fires, and volcanic activity. Orbital complex *Salyut 6/Soyuz 27* would continue its flight. (FBIS, Tass in English, Feb 12/78)

February 13: NASA announced it had tentatively selected 4 more experiments for its Long Duration Exposure Facility (LDEF) scheduled as a major Space Shuttle payload in 1980. The four scientific experiments—to study hazards to man of ion particles in space, the chemistry of micrometeoroids, the interstellar wind, and cosmic-ray nuclei—would join 23 technology experiments selected for LDEF earlier in 1978 [see Jan. 9]. LDEF, an unmanned reusable free-flying facility carrying technical and scientific experiments mounted in special trays, would offer an easy and economical way to expose primarily passive experiments to the space environment during 6 to 9 mo of LDEF orbit.

Selected experiments and principal investigators were: free-flyer biostack experiment, Dr. Horst Bucker, Universitat Frankfurt-am-Main, W. Germany; interstellar gas experiment, Dr. Don Lind, Johnson Space Center; high-resolution study of ultra-heavy cosmic ray nuclei, D. V. Domingo and Dr. K. P. Wenzel of ESA (the Netherlands), and Prof. C. O. Ceallaigh, Dr. D. O'Sullivan, Dr. A. Thompson of the Dublin Inst. for Advanced Studies, Ireland; and chemistry of micrometeoroids, Dr. Fred Horz, JSC. (NASA Release 78-20; LaRC Release 78-5; *JPL Universe,* Feb 3/78, 1; ESA newsletter, Feb 78, 3)

- Airport and aircraft noise-reduction legislation faced a rocky future, said *Av Wk*, because of congressional concern that safety needs were taking a back seat to retrofit and replacement for aircraft compliance with federal noise standards, and that the proposed scheme to fund safety measures was unacceptable. One bill under consideration would set up a voluntary program to assist airports and surrounding communities to reduce noncompatible land uses near airports. Main target of congressional concern was Title 3 of the bill, lowering by 2 percentage points the current domestic passenger-ticket and waybill taxes and replacing them with (among other charges) a 2% surcharge on tickets and waybills. Each airline would use surcharge funds for retrofitting, reengineering, or replacing aircraft to comply with recent federal noise standards. Witnesses testified, according to *Av Wk,* that about 75% of the 2100 jet engine aircraft in the U.S. airline fleet today had not met those standards.

"We believe," testified Transportation Secretary Brock Adams, "there are significant benefits to the public at large to be achieved by providing incentives for replacement of noisy aircraft with new technology aircraft, rather than merely retrofitting or reengineering." Among those with substantial concern over the surcharge was Rep. Al Ullman (D-Ore.), who said: "Everyone is trying to impose taxes that are really outside the tax system. How do you keep it in the tax system?" Representatives of the Aerospace Industries Association had testified in favor of the bill. (*Av-Wk,* Feb 13/78, 32)

- Robert Kirk, president and chief executive officer of Vought Corp., in a speech to the Aviation/Space Writers Association, had called for a comprehensive multinational treaty on international operations in space, reported *Av Wk*. "Why not a United Nations conference to work out international protection—not unlike the 'freedom of the seas' philosophy which has worked so well throughout the world for centuries?" Kirk asked. He said a treaty had to be approached as a totality, because space defense was only one element of a freedom-of-space policy. And he noted that treaty negotiators should consider all space systems on a broad international basis. "As you know," he pointed out, "Communist China and European Space Agency countries are already entering the picture, so issues are no longer confined to U.S. and Soviet interests. Therefore, in seeking an enduring treaty, a broad international forum is required. Most important," Kirk concluded, "any agreement must guarantee that we are free to operate—that any nation is free to operate—in space and to share its benefits. . . . A good treaty is an important step in this direction." (*AvWk*, Feb 13/78, 7)

• Aeritalia and the Italian ministry of research and technology had discussed a new Italian telecommunications-satellite program, *Av Wk* reported. Most of Italy's annual space budget had been devoted to ESA programs, but Italian government and industry had continued a limited number of strictly domestic projects, including the *Sirio* experimental comsat launched from KSC and the Alfa 2-stage booster that had qualified in three successful test firings from Italy's Saito di Quirra experimental test range. Current discussions of future satellite programs could lead to detailed telecommunications project studies this year, and development work beginning in 1979. A major space undertaking for Aeritalia was the ESA Spacelab; Aeritalia had been responsible for the structure of the pressurized Spacelab module. (*AvWk*, Feb 13/78, 41)

• INTELSAT announced it had signed agreements with Saudi Arabia and Zaire to lease capacity on global-coverage Intelsats for domestic telecommunications in those countries. Saudi Arabia had leased a total of 2.25 global-beam transponders, extending domestic service to 8 cities in addition to Jeddah, Riyadh, and 2 mobile antennas served since 1977. The 5-yr agreement with Zaire had earmarked a full global-beam transponder in a spare-capacity satellite to serve 13 locations in that nation. Fifteen countries had begun (or would soon begin) to use the Intelsat system for domestic telecommunications. (INTELSAT Release 78-5-I)

February 14: NASA announced two promotions: James Morrison to the position of European representative, and Louis Lushina to director of the information systems division, Office of Management Operations. For the past 3.5yr Morrison had managed the earth resources survey program in NASA's Office of Applications; before that, he had served for

12yr in NASA's Office of International Affairs. He had been an F-86 and F-100 pilot and served as a flight commander, operations officer, and squadron commander. As European representative, Morrison would be liaison between NASA and European space agencies.

In his new position, Lushina would be responsible for managing agencywide information-systems efforts and ADP resources. He had come to NASA in 1968 from the Army Materiel Command and had served since then as deputy of financial management in the Office of the Comptroller. Previously he was deputy comptroller of the U.S. Army Communications Zone in Europe and of the U.S. Army Supply and Maintenance Command, and assistant comptroller of the U.S. Army Ordnance Corps. He held the NASA exceptional service medal and the Army's meritorious civilian service medal. (NASA Release 78-23; NASA anno Feb 14/78, Feb 15/78)

- ESA reported first results from the international ultraviolet explorer launched Jan. 26. A European team working Feb. 9 at ESA's Villafranca station had located and observed Capella (a star in the Milky Way galaxy) for the first time in the complete ultraviolet spectrum. Like the sun, the strong-magnitude (bright) star appeared to be surrounded by an area called the chromosphere, in which chemico-gaseous exchanges occurred. IUE's program of scientific and technological observation would continue until the end of March. (ESA Release Feb 14/78)

February 15: MSFC announced NASA had extended the mission lifetime of the first earth-orbiting high-energy astronomy observatory *Heao 1*, originally scheduled to end Feb. 12, to at least mid-November when the second of the series was due for launch. The high quality of scientific data received from *Heao 1* had prompted the decision to extend the mission. Launched Aug. 12, 1977, *Heao 1* had been the first of three planned large unmanned orbital observatories managed by MSFC; the third would be launched in 1979. *Heao 1* had been a scanning mission for fully mapping the celestial sphere; the second Heao mission would point very precisely at x-ray sources identified by *Heao 1*, which had already significantly advanced knowledge of celestial x-ray and gamma-ray sources. By extrapolating these results, the scientists expected to increase the number of x-ray objects identified by the first 6 mo of data from 200 to 1000 or more, with further increases during the extended operation.

Heao 1, although basically a scanning instrument, had been versatile enough to stop its rotation and point briefly at items of particular interest; resolution and sensitivity would increase tremendously in the pointing mode. *Heao 1* was performing about 5 daytime pointings lasting about 3hr during a week; extended mission lifetime would enable the mission-control crew to add night pointings. Dr. Fred Speer, mission director, explained: "Astronomers would like to have their optical viewings and optical photography of stellar objects—which of course can only be done at night with optical telescopes—coincide with our pointings with the X-ray sensors aboard *Heao 1*, so that data can be correlated." (*Marshall Star*, Feb 15/78, 1)

• MSFC announced that the American Inst. of Astronautics and Aeronautics (AIAA) had installed Dr. William Lucas, MSFC director, as a fellow at the 14th AIAA annual meeting Feb. 8. AIAA had selected Dr. Lucas "in recognition of your many outstanding contributions and acknowledged leadership in the professional aerospace community," according to a letter from AIAA president R. H. Miller. Others named AIAA fellows were former astronauts Sen. Harrison Schmitt (R-N.M.) and David Scott, Dr. Donald Hearth of Langley Research Center, and Harvard Lomax of ARC. Elected an honorary fellow was former NASA Administrator Dr. James C. Fletcher. (*Marshall Star*, Feb 15/78, 1)

February 16: Scientists in NASA's Viking project this spring would award grants totaling $5000 to support undergraduate research projects in planetology or astronomy, NASA announced. The money had been part of the annual Newcomb Cleveland Award presented Feb. 15 by the American Assn. for the Advancement of Science (AAAS) to 150 Viking scientists, authors of scientific papers that had appeared in 3 special Viking issues of *Science* magazine. This had been the first Cleveland Award to a group. The grants, ranging from $500 to $2000, would fund a student's (or group of students') ideas or would supplement student work in progress, selected on the basis of originality and feasibility. (LaRC Release 78-7; *Langley Researcher*, Feb 24/78, 3)

• Modification and flight of U.S. Air Force jet cargo/tanker aircraft delivered to DFRC would allow NASA to research the possibility of significant fuel savings, NASA announced. Winglets (2.7m [9ft]-long airfoil sections attached to the wingtips of a KC-135 aircraft) could improve performance in cruise flight by approximately 8%, for an annual fuel saving of 11.9 million liters (45 million gal) based on 1975 use rates for KC-135 aircraft. Other NASA studies had indicated that use of the winglet could benefit existing medium-weight civil-transport aircraft.

LaRC had developed the winglet concept in its wind tunnels. Winglets, made of aluminum 0.6m (2ft) wide at the tip and 1.8m (6ft) wide at the base, could weigh almost 68kg (150lb). The Boeing Co. would install them on outer wing panels under an Air Force contract estimated at $3 million. Varying the incidence and cant angle of the winglets between flights would demonstrate their effectiveness at various positions. After installation of recorders, the KC-135 would make the first flights in a joint NASA-USAF program scheduled after winglet installation in early

1979. Comparison of data would demonstrate winglet effectiveness. (NASA Release 78-25)

• Using a multichamber furnace delivered to *Salyut 6* by the *Progress 1* unmanned tanker/freighter, Soviet cosmonauts had begun major space-processing experiments, Tass reported. Operated in a Salyut airlock to vent into the vacuum of space, the furnace had three areas: one maintaining heat up to 1100C, a "cold" area maintaining 600 to 700C, and a "gradient" area allowing linear temperature change between maximum and minimum furnace-heating capabilities. The Salyut space-processing system, designated "Splav" (alloy), would use material samples in capsules, each containing 3 crystal ampules to fuse when heated in the furnace and form monocrystals in the "gradient" area, with 3-dimensional crystallization in the hot and cold sections of the furnace. Combinations of materials heated to form new substances not possible in earth gravity would be aluminum/antimony, aluminum/tungsten, molybdenum/gallium, copper/indium, and indium/antimony. Some of the alloys might have semiconductor properties, suggesting that Soviet interest would be in specific applications in earth orbit rather than in theory.

The cosmonauts had also reported a major technology experiment using a closed-cycle cryogenic system designed to provide temperatures comparable to liquid helium (−269C) but did not say whether or not the test actually used liquid helium. Cosmonauts had also used cryogenics to cool the receivers of a "submillimeter telescope," Tass reported. (FBIS, Tass in English, Feb 15/78, Feb 16/78; Moscow Dom Svc in Russian, Feb 21/78; *AvWk*, Feb 27/78, 21)

February 17: NASA's *Skylab* workshop launched in May 1973 might descend to 150 nautical miles (173 statute miles, 278km) altitude and begin reentry into earth's atmosphere as early as late summer of 1979, *JSC Roundup* reported, citing orbit data from the North American Air Defense Command's satellite trackers, the Smithsonian Astrophysical Observatory, and the Swiss federal observatory. NASA would try two ways of postponing *Skylab* reentry: first, to reactivate the workshop's thruster attitude-control system in the spring of 1978 and put it into a very slow tumble, decreasing atmospheric drag and perhaps adding several months to its orbital lifetime; second, to use a teleoperator-retrieval system (TRS) launched on an early Space Shuttle mission (about Oct. 1979) and flown by remote control to dock with *Skylab*. Once docked, the TRS propulsion system could either raise *Skylab*'s orbit or control its reentry.

Although *Skylab* would break up and burn during descent, some debris would probably survive reentry, and probably would land in an ocean, because 80% of the *Skylab* orbit had been over water (between 50°N and 50°S). *Skylab*, largest payload in earth orbit at 85 tons, and about 96ft in length, had been manned during 3 missions by 3 different astronaut crews. When the last crew had left *Skylab*, NASA estimated the workshop would remain in orbit until 1983; however, its altitude had dropped more rapidly than expected because of increased atmospheric drag caused by sunspot activity. (*JSC Roundup*, Feb 17/78, 1; *DFRC X-Press*, Feb 10/78, 2; *Marshall Star*, Feb 8/78, 4; *W Post*, Feb 2/78, A-2; *C Trib*, Feb 6/78, Sec. 1; *Nature*, Feb 9/78, 499)

- A laser-heterodyne radiometer (LHR) developed by Dr. Robert Menzies of the Jet Propulsion Laboratory had obtained evidence of ozone destruction in the upper atmosphere, JPL reported. The unique instrument, carried on a gondola suspended from a helium-filled polyethylene balloon, had gathered extremely accurate data by "looking" at the sun through the stratosphere during sunset at an altitude of 25km (120 000ft) where ultraviolet light breaks apart carbon molecules, releasing chlorine. Atoms of chlorine normally existed in quantities so small that their presence was difficult to detect; however, scientists had determined the effect of chlorine in destroying ozone, through a chain reaction that would form chlorine monoxide molecules. Later flights would measure the effect of seasonal variations and would look for other molecules responsible for ozone destruction. The research would assist federal regulators investigating danger from fluorocarbons used in refrigeration and air-conditioning; regulators might decide to ban aerosol propellants by June of this yr. (*JPL Universe*, Feb 17/78, 1)

- JSC reported it had begun a new procedure for receiving and processing rare and pristine meteorite samples. Such a program had not been necessary previously because available meteorite fragments had been contaminated by reaction with the soil where they fell, by weather, and by often unsterile handling conditions. The new meteorite facility would contain a near-pristine meteorite collection found in the winter of 1977 near McMurdo Station in Antarctica; the first two meteorite samples were 200- to 300-gram (baseball-size) fragments believed by NSF to be rare carbonaceous chondrites that might include primordial matter from the solar system.

Dr. William Cassidy, Univ. of Pittsburgh geologist working under an NSF grant, who had found the samples on an Antarctic ice shelf, had hypothesized that large accumulations of meteorites might exist in areas of the Antarctic, where ancient "blue ice" rose to the surface. Meteorites that fell on Antarctica centuries ago might appear on the surface along with the ice. Although the movement of the ice to the surface was not well understood, within 2 mo (last Dec. and Jan.) Cassidy had found 310 fragments believed to represent between 20 and 50 different meteorites, the most concentrated find known so far. Because of the exceptional preservation possible in the extreme cold and dry environment, Cassidy's find of 310 samples was probably the least contaminated near-pristine meteorite group ever collected. To ensure proper handling, the NSF and NASA's Lunar Curatorial Facility in Houston had equipped Cassidy with special sterile equipment to safeguard his collection.

Researchers at the meteorite-processing facility, using glove boxes first used to handle material from the moon, would document the samples and make initial characterizations before freeze-drying them to remove any trapped water-ice and making a mold, finally storing the samples in dry nitrogen gas. A special committee representing the NSF, the Smithsonian Museum of Natural History, NASA, and Dr. Cassidy's team would plan systematic examination of the samples. (*JSC Roundup*, Feb 17/78, 1)

February 20: AvWk reported that NASA had been struggling with institutional and funding arrangements for launching a Hughes-built comsat, Syncom-4, without giving Hughes the unfair advantage of a free Space Shuttle launch. The problem required prompt attention, because NASA had to make decisions within a few weeks if Syncom-4 was to fly on an early Shuttle mission.

Hughes had designed and offered Syncom-4 specifically to fit the Space Shuttle payload-bay design, since NASA had wanted to deploy a test spacecraft on a Shuttle orbital mission. Under the Hughes proposal, the spacecraft would have no significant communications capability, and NASA would launch the unit free of charge; however, the satellite-user community (the state of California, Agency for International Development, and the Interior Dept.) had asked that the spacecraft include some communications capability instead of merely verifying a design. NASA had to decide who would pay for the added capability and whether Hughes would have an unfair advantage.

Without a decision, NASA Administrator Dr. Robert Frosch said the whole exercise could revert to the original concept, with no significant communications channeled through the satellite. NASA might decide to run an open competition for systems to demonstrate Shuttle-launched communications spacecraft in the same manner as Syncom-4. However, Frosch was concerned that in an open competition Hughes could be "competed out of it in a way that is not quite proper," since the Syncom-4 concept had been a Hughes innovation. "As it has developed," Frosch explained to a House appropriations subcommittee hearing, "it is not completely clear that there is a proper solution to this dilemma." (*AvWk*, Feb 20/78, 60)

- The Canadian government had asked the USSR to pay possibly more than $2 million as the cost of an extensive search to recover debris from *Cosmos 954*, *AvWk* reported. Canada's request was in accord with a

1968 United Nations agreement that "expenses incurred in fulfilling obligations to recover and return a space object or its component parts . . . shall be borne by the launching authority." The Canadians had delivered an official statement to the Soviet embassy in Ottawa that pieces of *Cosmos 954* had landed on Canadian soil Jan. 24, and that Canada would return the debris to the USSR on receipt of the desired payment. The Canadians had also sent the UN a note reserving the right to claim compensation under the 1968 UN agreement, and announcing their intent to request compensation from the USSR. The report did not specify the amount of compensation requested. (*AvWk*, Feb 20/78, 24)

• A Soviet-French complex of thermostatic equipment on *Soyuz 27* had passed the test of terrestrial and space conditions, Tass reported. Soviet and French biologists had prepared biological cultures and chilled them in an ordinary refrigerator before putting them into the semiconductor instrument "Termokont-2." On the night before the *Soyuz 27* launch, Termokont-2 had handed over its biological "load" to another Soviet instrument, the thermostat "Bioterm-8," to maintain a temperature of 8°C during the launch and orbit of *Soyuz 27* until it docked with *Salyut 6*. After docking, the biological insert had gone into the French semiconductor thermostat "Cytos," which thawed the cultures and began to study spaceflight influence on cellular division of microorganisms under the strictly controlled temperature of 25°C. (FBIS, Tass in English, Feb 20/78)

February 21: NASA announced results of a demonstration of curriculum-sharing planned by LaRC using television through the communications technology satellite *Cts* at North Carolina A&T State Univ., Greensboro, N.C. This was the first time a predominantly black college had participated in such an experiment. NASA's portable earth terminal (PET), a ground-based communications system contained in a trailer, had transmitted 2 days of telecasts originating at North Carolina A&T to *Cts* 22 500 mi up, which relayed the programs to Jackson State Univ. in Miss.; Bell-Northern Research Ltd., Ontario, Canada; and Stanford Univ. and Rockwell Intl. in Calif. Participants in each location could see and communicate with each other. The program, funded under NASA contract to demonstrate the use of satellites in sharing curriculum information, research techniques, and results, included a question-and-answer session with Frederick Gregory, black Shuttle astronaut recently selected by NASA. ARC had made available almost 7 hr of satellite time for the project. (LaRC Release 78-9; NASA photo L-78-1209; *Langley Researcher*, Feb 24/78, 1)

• The number of airports, heliports, and other landing facilities available to civil aircraft in the U.S. and its possessions had increased in

1977 to 14 117, a net gain of 347 from the previous year, the Department of Transportation reported. Figures included civilian landing facilities and military facilities that permitted civil-aircraft operations. Privately-owned landing facilities accounted for more than 300 of the increased number, from 9103 in 1976 to 9409 in 1977. The 1977 year-end total included 11 713 airports, 1850 heliports, 513 seaplane bases, and 41 short-takeoff-and-landing (STOL) airports or runways, as well as 48 facilities in U.S. possessions. Landing facilities abandoned in 1977 numbered 294. Of the total, 747 were served by air carriers holding certificates of public convenience and necessity issued by the Civil Aeronautics Board. (FAA Release 12-78)

February 22: NASA announced plans to launch Landsat-C, an improved satellite to monitor earth resources, from WTR March 5 aboard a 2-stage Delta vehicle. Third of a series designed to orbit earth at 917km (570mi) altitude and scan earth's surface in a systematic resources and environment study, Landsat-C would be placed in a near-polar orbit circling earth every 103 min. Its remote sensors would view a 185km (115mi)-wide strip of earth running nearly north-to-south at a 99° angle to the equator. Earth-surface coverage would proceed west, with a slight overlap, covering the globe every 18 days. Synoptic repetitive coverage under consistent observation conditions was required for maximum use of the multispectral imagery.

Most important uses of Landsat data would correspond to three of the world's major problems: energy supplies, food production, and global large-scale environment monitoring. Innovations in the multispectral scanner system (MSS) would permit detection of day and night temperature differences in vegetation, bodies of water, and urban areas. The return beam vidicon (RBV) sensor improvements would increase recorded image resolution by 50%. Areas as small as half an acre would be identified and studied. Landsat-C also carried a data-collection system (DCS) that would collect data radioed directly from as many as 1000 remote ground platforms and relay them to a Landsat data-acquisition station. The DCS would collect data on volcano activity, stream flow, water and snow depth, water temperature, and sediment density.

Goddard Space Flight Center was responsible for project management of the Landsat spacecraft, Delta launch vehicle, NASA image-processing facility, and worldwide tracking network. KSC would supervise launch. General Electric Co.'s Space Division was Landsat spacecraft prime contractor. (NASA Release 78-22)

- NASA announced it had selected Teledyne Brown Engineering, Huntsville, Ala., for negotiations leading to award of a contract for payload/missions integration for the sixth Space Shuttle orbital flight test and for the first 3 Spacelab missions to be managed by MSFC. An experiment-integration contractor, Teledyne Brown would ensure that the group of experiments for each mission was compatible with the Space Transportation System scheduled to carry it into orbit. The contract would provide for manpower, materials, and associated services required for integration and operation of Spacelab payloads. Flights scheduled during 1980 to 1981 would offer opportunities for scientific investigations on Spacelab missions in the planning stage with scientists from throughout the world participating. These missions would give scientists the first chance to go into space as payload specialists and conduct their investigations in earth orbit. (*Marshall Star*, Feb 22/78, 1)

• MSFC reported a two-wk visit by 13 Japanese scientists doing initial design review of the SEPAC (space experiments with particle accelerators) package to be flown on Spacelab 1. Heaviest and most complex of the experiments scheduled for that mission, the SEPAC had 16 scientific objectives in addition to proving its performance and compatibility with the Spacelab. It had been designed for multiple reuse, and would accommodate a number of scientific disciplines. The particle accelerator, for example, would shoot an electron beam to create a small-scale artificial aurora in the upper atmosphere, timed to occur at a specific location for simultaneous observations from space and from earth for later comparison.

Professor Tatsugo Obayashi of the Institute of Space and Aeronautical Science at the Univ. of Tokyo said that nature had provided ideal laboratory conditions in space for many experiments. "There we can actively interact with nature and, by artificially exciting the electrons and ions of plasma and studying the results, we can eventually define the dynamics of space." The Japanese scientists had been working on the SEPAC experiment since early 1976. (*Marshall Star*, Feb 22/78, 4)

• NASA announced that LaRC would sponsor a government-industry conference Feb. 28-March 3 on technology advances in design and operation of conventional takeoff-and-landing (CTOL) transport aircraft. Technical sessions would present new technology generated by NASA in-house and contract efforts, including the ongoing Aircraft Energy Efficiency Program (ACEE). Speakers would represent organizations in the airframe and engine industry, universities, and 4 NASA centers. The 45 presentations would be organized into 6 disciplinary sessions: propulsion, structures and materials, laminar-flow control, advanced aerodynamics and active controls, operation and safety, and advanced systems. (LaRC Release 78-10)

• FBIS, in an unattributed commentary in English, reported that the USSR had been testing a laser system called "Glissada" that might permit safe airline takeoffs and landings in any weather. Questioning Professor Igor Berezhnoy, the commentator said: "The new system enables the pilot, in any weather without any additional aids, to find his airfield and the landing strip." Berezhnoy explained: A few dozen km from the airfield the pilot would see 3 red laser beams motionless, like pillars, over the airfield and would discern other beams, 2 red beams clearly indicating runway boundaries and a third directly down its middle; it is this axial beam that the plane would follow to land. The system would enable the pilot to detect even a half-meter deviation from course. The laser system would require little additional training of pilots and no additional equipment on the planes. The Soviets claimed the cost of the system and its installation and maintenance would be a fraction of the cost of present radio systems and airport-lighting equipment. (FBIS, unattributed commentary in English, Feb 23/78)

February 23: LaRC reported NASA had appointed astronaut Donald Slayton to manage the orbital-flight test (OFT) program for Space Shuttle at JSC. One of the original 7 Mercury astronauts and a member of the U.S. crew of the Apollo-Soyuz test project, Slayton would be responsible in his new position for all mission-unique activities associated with the 6 Shuttle orbital-flight tests scheduled to begin in the spring of 1979. He would represent program manager Robert Thompson across the total program to ensure timely and appropriate resolution of all OFT mission-unique issues. (LaRC Release 78-12)

February 24: NASA announced that *Nimbus 6*, a meteorological research satellite, would track the 6000km (3728mi) journey by dogsled of a lone Japanese explorer from northern Canada to the North Pole and back. The Smithsonian Institution, which had a scientific stake in the venture, had asked GSFC to manage the tracking. The 6-mo journey would begin March 4, 1978. The explorer, 37-yr-old Naomi Uemura of Tokyo, had driven a dogsled solo some 12 000km (7457mi) from Greenland to Alaska over an 18mo period in 1975 and 1976. During his upcoming Arctic journey, Uemura would carry a 4.5kg (10lb) battery-powered satellite beacon on his dogsled to transmit once per min an automatic radio signal, including local temperature and atmospheric pressure. *Nimbus 6* overflying the pole every 108min would monitor the signals and collect the data for relay to GSFC by a NASA tracking station in Fairbanks, Alaska, Uemura would systematically collect snow, ice, and air samples for Japan's Natl. Inst. of Polar Research and the Water Research Inst. of Nagoya Univ. Researchers needed as accurate a record as possible of Uemura's daily positions to correlate with the collected data. Satellite-tracking data would also verify Uemura's dead-reckoning and celestial-navigation readings, particularly difficult in polar regions. NASA's expenditures on the venture would be minimal because both the *Nimbus 6* and its ground-control computer would be routinely operating on a 24hr basis. (NASA Release 78-29)

- DFRC reported that it had awarded the Ames Industrial Corp., Bohemia, N.Y., a $218 000 fixed-price contract to develop and fabricate a small lightweight manned oblique-wing aircraft. NASA had begun a low-cost study of piloting an oblique-wing aircraft. At lower flight speeds, the wing would orient itself perpendicular to the fuselage, producing efficient quiet operation for takeoff and landing and for low-speed cruise flight. This would substantially reduce engine thrust required for takeoff, resulting in quieter operations during takeoff and landing. In high-speed flight, the wing would pivot fore and aft, forming oblique (up to 60°) angles with the aircraft fuselage.

Studies had suggested the "scissor-wing" concept would offer better flight performance at high speeds; as an aircraft went faster, pivoting the wing to an oblique angle would decrease air drag, giving increased speed and longer range for the same fuel expenditure. Computer and wind-tunnel studies at ARC had shown that an oblique-wing transport aircraft flying at 1000mph might realize twice the fuel economy of either the current British-French Concorde or the Soviet SST, and also might alleviate the sonic-boom problem. DFRC expected delivery of the aircraft in late 1978 and planned its first flights early in 1979. (*DFRC X-Press,* Feb 24/78)

February 26: NASA announced that scientists working for NASA and NSF had discovered living organisms inside rocks on the frozen deserts of the Antarctic. The discovery, made in a region called the Dry Valleys whose harsh climate resembled conditions on Mars, would significantly extend the known limits of life on earth, and would have important implications in a search for extraterrestrial life.

Dr. E. Imre Friedmann and Dr. Roseli Ocampo-Friedmann, a husband-wife team who had searched for more than 15yr for microbial life in rocks, had made the discovery. They had isolated the newly discovered microorganisms (bacteria, algae, and fungi) and were growing them in laboratory cultures for clues to their endurance. Although the Dry Valleys of Antarctica had appeared lifeless, and the region's freedom from snow and ice, combined with constantly blowing winds, had produced an environment among the world's harshest, the Friedmanns had found in the Dry Valleys a widespread rich microbial vegetation under the surface of rocks, in the airspaces of porous rocks, or in fissures. Rocks broken open had revealed the presence of organisms as a dark-green layer a few millimeters deep.

Dr. Richard Young, NASA's chief of planetary biology, said the Dry

Valleys in many ways resembled the environmental extremes found on Mars by the 1976 Viking landers, which searched the Martian soil unsuccessfully for signs of microbial life or organic molecules. "If Martian life forms exist only in the interior of Martian rocks, as is principally the case in the Antarctic, that could easily serve as an explanation for the lack of evidence on Mars," Young said. "This interesting (if speculative) analogy is of considerable interest to NASA in designing future attempts to study planetary surfaces for evidence of life." NASA and NSF research grants had supported the Friedmanns' work. (NASA Release 78-14)

February 27: Dr. Robert Frosch, NASA administrator, announced a reorganization at NASA Hq to significantly restructure organization elements such as Aeronautics and Space Technology, Space and Terrestrial Applications, External Relations, and Management Operations, with lesser changes in the Equal Opportunity, Procurement, and Audit organizations. Frosch's Feb. 22 approval of the new organization structures had authorized office heads to proceed with final placement of people.

In explaining the reorganization, Alan Lovelace, deputy administrator, said: "In keeping with the announced policy of President Carter, each Headquarters employee affected by the reorganization will be made a good-faith offer of a position and to the extent possible the offer will be made at the employee's current grade level. As I announced previously, there will be no involuntary reduction in force at NASA Headquarters. . . . The classification survey of Headquarters positions has been completed. Based on tentative aggregate findings in the survey thus far, plus the potential impact of the reorganization, Dr. Frosch has asked the Civil Service Commission for authority to delay any demotions for people in the General Schedule resulting from survey results and the impact of the reorganization. NASA was granted such authority on Feb. 22. . . . As to future classification activity, it is important that we maintain a rigorous system for the accurate classification and grading of all Headquarters positions. . . . I would like to assure you that we are taking all of the steps possible to provide appropriate job opportunities for all Headquarters employees and, to the extent we can, we shall do our best to avoid adverse impacts." (NASA special anno Feb 27/78)

- *Av Wk* reported that Congress might override President Carter's decision not to fund a fifth Space Shuttle orbiter in NASA's FY79 budget. Congressmen of both parties had said that a 4-orbiter fleet would limit the development of a civilian space program, making the U.S. extremely vulnerable in strategic use of space. Officials who considered addition of a fifth orbiter inevitable had pointed out that Carter's decision to defer acquisition would increase Shuttle program cost by $235 to $250 million if the administration should later change its mind. Some congressmen had also expressed displeasure with the administration's apparent inability to provide stated goals and directions for NASA's space capabilities and with the attempt to cut NASA advance-planning funds. (*AvWk*, Feb 27/78, 20)

• *Av Wk* reported award to Lockheed Missiles and Space Co. of a $34.5 million USAF contract to design and build a space platform using long wavelength infrared radiation for space surveillance of relatively cool objects. Designated space test program mission P80-2, to be managed by USAF's Space and Missile Systems Organizations (SAMSO), the platform would go into orbit from WTR in Jan. 1981. Principal payload for the P80-2 mission would be a satellite infrared experiment (SIRE) developed for USAF by Hughes Aircraft Co., to operate in the 8- to 12-micrometer region of the spectrum, detecting and tracking objects such as a spacecraft or booster after burnout. The platform would also carry an autonomous navigation system built for USAF by Martin Marietta and a solar-flare isotopic-composition experiment designed by the Univ. of Chicago. The contract provided that Lockheed would integrate the payload (for which it had no responsibility) with the space platform. (*AvWk*, Feb 27/78, 39)

• Congress had strongly supported legislation establishing a power satellite research and development and demonstration program scheduled to become a major issue among changes to President Carter's FY79 solar energy proposals, *Av Wk* reported. Rep. Ronnie Flippo (D-Ala.) had introduced a bill directing the Dept. of Energy and NASA to begin research and development on technical problems in implementing a solar power satellite. However, Dale Myers, undersecretary at DOE, who had described the joint solar energy projects contemplated by NASA and DOE at a House Science and Technology space science and application subcommittee hearing, said he questioned the need for such a bill. (*Av Wk*, Feb 27/78, 47)

February 28: The *Congressional Record* reported that President Carter had nominated former astronaut Maj. Gen. Thomas Stafford to be Air Force deputy chief of staff for research and development. Stafford, who had spent more than 500hr in space, was serving as commander of Edwards AFB Flight Test Center. The nomination, which carried a promotion to the rank of Lt. Gen., was subject to Senate confirmation. (*CR*, Feb 28/78, S 2580; *NYT*, Feb 26/78, (27), 14)

During February: Gossamer Condor, the manpowered aircraft that won the $85 000 Kramer prize in 1977, was on display at the National Air and Space Museum in Washington, D.C., the National Aeronautic Association reported. The 96-ft wingspan had been cut into 4 pieces for shipping across country with the fuselage and stabilizer. Gossamer Condor had the largest wingspan and was the lightest of any plane in the museum, the wing-covering accounting for only 4.5lb of the craft's total 70lb. An intricate web of piano wire held the structure together. Flight speed, reaching 10mph, had required the manpower equivalent of one-third of a horsepower. Designer Paul MacCready had substantiated his belief in the potential of ultralight craft. (NAA newsletter, Feb 78, 4)

• The Carter administration, calling for national commemoration of the 75th anniversary of the Wright brothers' first powered flight, had designated DOT lead agency to coordinate programs and materials, the National Aeronautic Association reported. The task force for the 75th anniversary, which had held its first meeting at DOT in Jan., would be a clearinghouse to avoid duplication, facilitate innovation, and develop ideas suitable for agencies and private organizations. Peter Clapper, FAA assistant administrator for public affairs, noted that the American people had taken for granted the tremendous advances in aviation over the last 75yr and that the anniversary offered an opportunity to bring these advances to public attention. (NAA newsletter, Feb 78, 1)

• Rep. Melvin Price (D-Ill.), chairman of the House Armed Services Committee, had written President Carter expressing concern that recent administration decisions could seriously impair the strategic defense posture of the U.S., the National Aeronautic Association reported. Price wrote: "I have attempted to comprehend the rationale behind the combination of decisions leading to cancellation of the B-1, cancellation of production of the Short Range Attack Missile (SRAM), terminating production of the Minuteman III Missile, and the reduction in funds for the development of the advanced MX missile system." He emphasized that, despite the consensus of defense experts that U.S. silos would be vulnerable within 3 to 5yr, the President had reduced MX funds and stretched out its schedule.

Price also voiced concern over the apparent lack of correlation or adequate interchange between the military departments principally responsible for strategic capability and others in the administration principally responsible for preparing proposals for and participating in SALT negotiations. Price concluded: "It is my hope that working with the administration we can be prepared (at the time the fiscal 1979 defense program is considered) to begin to provide those systems necessary to ensure a halt to the trend that sees the United States falling behind the strategic might of the Soviets." (NAA newsletter, Feb 78, 1)

• The USAF announced it had selected McDonnell Douglas Corp., Long Beach, Calif., as primary contractor for the advanced tanker cargo aircraft (ATCA). Award of the $28 million contract would initiate production-engineering tooling and other nonrecurring activities. The aircraft would be funded over the next 5yr, with the intent of eventually ordering 20 of them. Primary objective of ATCA would be to increase mobility of U.S. forces in contingency operations by refueling fighters and simultaneously carrying fighter-support equipment and personnel on overseas deployments; refueling strategic airlifters (such as C-5 and C-141) during overseas deployments and resupply missions; refueling strategic offensive and reconnaissance aircraft during long-range conventional operations; and selectively augmenting cargo-carrying capability. (AFSC *Newsreview*, Feb 78, 1)

- The USAF announced it had tested at Ramstein, W. Germany, a new "brain" for the imaging infrared (IIR) Maverick missile, a digital centroid tracker developed for a joint Air Force-Navy IIR program by Hughes Aircraft Co., to prevent loss of target lock-on, a problem inherent in the older analog system. The centroid tracker would locate a target such as an industrial complex or tank using a sensor that picked up infrared or heat images, calculated boundaries of the target, and guided the missile to the approximate center. The IIR Maverick (designated AG65D), most advanced version of this new missile, had demonstrated in tests earlier this year improved performance in daytime or nighttime and adverse weather conditions over earlier TV-guided Mavericks. (AFSC *Newsreview*, Feb 78, 4)

- The Jan/Feb issue of *Satellite Pathways* reviewed COMSAT accomplishments, noting that satellite communications technology had advanced through research and development programs at COMSAT Laboratories, engineering support it had provided to current satellite systems, and its work on satellite systems of the future. COMSAT's research and engineering programs had aimed primarily at more powerful and long-lived multiple-beam satellites operating with smaller earth stations in higher communications frequencies; these programs would lead to more efficient use of the frequency spectrum allocated to satellite communications by simultaneous multiple use of the same frequency bands and transmitting communications in high-speed digital rather than conventional analog modes.

Among achievements in 1977, the article mentioned new nickel-hydrogen batteries developed by COMSAT under INTELSAT sponsorship; data collected from COMSAT-built 13- and 18-gigahertz transponders aboard the *Ats 6* satellite and the 19- and 28-gigahertz beacons aboard the COMSTAR satellites; a simulator that could handle communications for the Intelsat V satellites that would form a global system in the 1980s; and new communications processing equipment to convert conventional analog signals into digital signals, and vice versa. (*Satellite Pathways*, Jan/Feb 78, 12)

- *Science Indicators 1976*, ninth annual report of the National Science Board recently transmitted to Congress by the President, noted an increase in U.S. research and development expenditures during 1976 to an estimated $38.1 billion in current dollars; however, constant-dollar spending of $28.5 was only 2.5% above the 1974 level. Measured in current dollars, federally supported R&D expenditures in 1976 had climbed to an estimated new high of $20.1 billion; however, constant-dollar levels stood at $15 billion, 18% below the peak reached in 1967. National spending for basic research in current dollars had climbed substantially since 1960, to a new high in 1976. However, estimated constant-dollar expenditures in 1976 had advanced only about 2% above the 1975 level, remaining nearly 11% below the peak year of 1968. The federal government was the source of most support for basic research in 1976, as it had been in past years. The federal share amounted to 68% of the total since 1971, compared with approximately 60% in 1960, whereas industry's share had remained stable at approximately 15% throughout the 1970s, in sharp contrast to its 28% share in 1960. (NSF report, Feb 78)

March

March 1: Marshall Space Flight Center engineers reported completion of tests simulating checkout of a solid-fuel rocket booster (SRB) using flight-type hardware interfaced with the launch-processing system (LPS) and tests run by computer. The tests would verify compatibility of SRB hardware and demonstrate use of the LPS to checkout the SRB system. Flight equipment removed from simulated SRB hardware had been relocated in equipment racks to simulate a left-hand SRB configuration; next use of the LPS would be to checkout the left-hand SRB. United Space Boosters, Inc., would perform the checkouts, then move the equipment to Kennedy Space Center for use in future SRB checkouts. (*Marshall Star*, Mar 1/78, 2)

• NASA announced appointment of Norman Terrell as director of international affairs and Arnold Frutkin as deputy associate administrator for external relations. Terrell, who joined NASA in 1977 as chief of the International Program Policy Office where his responsibilities included U.S.-Soviet space relations and United Nations space affairs, had worked for the Nuclear Regulatory Commission and as foreign service officer in the State Department, where he received an award in 1975 for his work on the threshold test ban treaty. Frutkin, who had headed NASA's Office of International Affairs for the past 18yr, had served as deputy director of the U.S. National Committee for the International Geophysical Year. (NASA anno Mar 1/78)

March 2: The USSR had launched *Soyuz 28* at 4:28pm Moscow time, Tass announced, with cosmonaut Vladimir Remek of Czechoslovakia accompanying Soviet cosmonaut Aleksey Gubarev on the first of a series of international cooperative flights that would include representatives from Bulgaria, Hungary, the GDR, Cuba, Mongolia, Poland, and Romania. Soyuz launches later in 1978 would carry Polish and GDR cosmonauts. Since 1967 when the Intercosmos program began, scientists and specialists of participating countries had been using Soviet satellites and research rockets to study the physical properties of outer space, space meteorology, communications, biology, medicine, and natural resources. (FBIS, Tass in English, Mar 3/78)

March 3: NASA announced award of a contract worth approximately $10.5 million to RCA for a high-quality television camera system to transmit live color and black and white TV during manned orbital Space Shuttle flights. The closed-circuit TV camera system installed on the Space Shuttle would photograph earth-orbital missions starting in 1979 through the 1980s. Under contract to Johnson Space Flight Center, RCA would provide up to 50 cameras for approximately 500 Shuttle flights over the next decade. Each Shuttle orbiter might carry up to 6 cameras; the system would consist of several TV cameras, a video control unit, pan and tilt mechanisms, and various monitors. Cameras installed in the crew compartment, cargo bay, and on a remote manipulator arm would use a 525-line standard compatible with broadcast television. A portable TV camera used during astronaut extravehicular activity (EVA), for example, could look at areas of the orbiter not visible to the permanently mounted cameras. The portable camera equipped with its own viewfinder would allow astronauts to focus accurately on an object such as the moon or a free-flying satellite in space. The TV system should help the crew in retrieving satellites from space, removing spacecraft from the cargo bay of the Shuttle, and repairing or replacing parts of a satellite on the servicing platform mounted in the orbiter's payload bay. (*JSC Roundup,* Mar 3/78, 1)

• Jet Propulsion Laboratory announced it had fabricated and displayed a prototype roving ball planetary explorer, an instrument-laden reinforced-fabric ball capable of inflating and deflating automatically or on remote command from earth during possible Mars exploration. Driven by high winds known to prevail on the planet's surface, or powered and steered by an inner drive system much like that of a bicycle, such balls or balloons could roam freely and conduct scientific experiments and measurements over a vast area. A ball could partially deflate if necessary for additional study of a particular area. This "bouncing ball" would offer the advantages of low cost, long life, and extended traverse of the planet's landscape. As a Mars explorer, a ball would constitute a payload of 20 to 30kg (about 44 to 66lb) capable of a traverse of 100 to 200km (60 to 120mi). The "skin" of the ball, "sandwiched" or laminated Mylar and Kevlar (both registered DuPont products), would be strong enough to cover some of Mars's most difficult terrain. Schjeldahl Corp. designed and built the ball for the Aerospace Corp. for the ATMOSAT project. Jacques Blamont of France's Centre National d'Études Spatiales (CNES) had proposed the concept. (JPL *Universe,* Mar 3/78, 1)

• Remote control might soon operate the two drawbridges linking KSC with the Florida mainland over the main channel of the Intracoastal Waterway, NASA announced. An experimental remote-control system tested on the 170-ft-long twin-leaf bridge spanning Haulover Canal would be a prototype for a permanent system both at the canal and at the dual-bridge span of the NASA causeway across the Indian River. The experimental system should demonstrate the feasibility and cost-effectiveness of remote bridge operation; in actual use, a duty officer in the launch-control center would use TV cameras, loudspeakers, and microphones mounted on the bridge to monitor and talk with canal and road traffic. A small microwave dish atop the bridge-control tower would transmit TV signals to a receiver on top of the 525ft-tall vehicle assembly building at KSC, and audio signals would travel by telephone wire. An operational system could save approximately $200 000 per yr and pay for itself over 4yr. (KSC Release 22-78; *Spaceport News,* Mar 3/78, 1)

- Langley Research Center announced it would host Mar. 7-9 an advanced technology airfoil research conference offering the aviation community a comprehensive review of the latest technical developments in airfoil computational analysis and design methods, airfoil test facilities and techniques, and various applications of new airfoil technology. Presented by NASA, supporting contractors, and university grantees, the technical sessions would cover progress in mathematical codes for use in electronic digital computers for airfoil analysis and design, coupled with progress in analog computers through wind-tunnel test facilities and special techniques of investigation; general aviation aircraft; transports; rotorcraft; propellers; windmills; and agricultural aircraft. (LaRC Release 78-12)

March 6: NASA announced plans to launch from Cape Canaveral no earlier than Mar. 23 an experimental Japanese direct-broadcast communications satellite capable of sending television programs directly into an individual's home. The satellite, technically named Medium-Scale Broadcasting Satellite for Experiment Purposes (BSE), had been a project of Japan's National Space Development Agency (NASDA). As agreed by the U.S. and Japan, NASA would launch BSE on a Delta rocket; NASDA would reimburse NASA for the cost of the launch vehicle, launch services, and other administrative costs. NASA's worldwide Spaceflight Tracking and Data Network (STDN) would track BSE until it achieved final orbit, when NASDA would take over tracking. Present Japanese TV, though covering 97% of the main islands, had not been economical for remote islands and mountain regions; also, tall buildings had degraded TV reception in large cities. NASDA had designed BSE to transmit high-quality color television to the Japanese islands and Okinawa at lower cost; user antennas could be as small as 1 to 1.6 meters (3.3 to 5.2ft), with production costs estimated at $200 per unit. The high power of BSE could transmit directly to individual TV sets even in bad weather, making TV available to Japanese living on the offshore islands and in inaccessible mountain areas.

Goddard Space Flight Center would manage the Delta vehicle for NASA's Office of Space Transportation Systems, and KSC would manage launch operations. General Electric Co., Valley Forge, Pa., had built the BSE under contract to Tokyo Shibaura Electric Co. The Japanese Broadcasting Corp., the Japanese Ministry of Post and Telecommunications, and the Radio Research Laboratories of Japan would sponsor or participate in the program. (NASA Release 78-33; MOR M-492-212-78-01 [prelaunch], Feb. 28/78; *Spaceport News*, Mar 17/78, 1)

• The House subcommittee on space science and applications had added funding of $4 million to the NASA FY79 budget for a fifth Space Shuttle orbiter and a new stereosat earth resources spacecraft, *AvWk* reported. The subcommittee had also added $7 million to NASA's Office of Space Transportation funds for advanced planning, plus $3 million each for large space-structures work and solar power satellite studies. (NASA's initial budget request had not included solar power satellite funding, because of Dept. of Energy priority in this area.) The subcommittee had added $40.5 million to the NASA request and cut $25 million, resulting in a net $15.5 million increase.

Funds for a stereosat came with a subcommittee call for development of the $40- to $45-million spacecraft based on significant funding from the user community; primary users would be geologists exploring for petroleum and minerals. Other subcommittee additions were $10 million for distribution of Landsat data and training programs to states for crop-prediction research, encouragement of microwave development, and work on an operational Landsat system; $4 million to stimulate bioengineering work; $1.5 million to support industrial application of NASA technology; and $4 million for modifying NASA's tracking system to facilitate full and timely handling of Spacelab data early in Spacelab's flight program. (*AvWk*, Mar 6/78, 13)

• *AvWk* reported that the Navy's Electronic Systems Command planned to issue a request for proposals (RFP) to establish and operate a follow-on system to the Navy/TRW fleet satellite communications (FltSatCom) system. The Navy would lease from the contractor capacity on the new system, designated Leasat, which could be either a hybrid (providing service to merchant shipping as well as to the Navy) or dedicated (serving only the Navy). The RFP would require 3 satellites positioned over the Atlantic, Pacific, and Indian oceans. The first satellite should be available Oct. 1, 1981; the second, Apr. 1, 1982; the third, Oct. 1, 1987. A satellite that failed would have to be replaced within 30 days. The contractor would also build and operate a telemetry, tracking, and control system with central headquarters for coordination at 4 Navy communications stations in Va., Hawaii, Calif., and Guam. (*AvWk*, Mar 6/78, 14)

- Upon successful completion of the Spacelab Critical Design Review [see Feb. 3], ESA announced it would authorize manufacture of the Spacelab flight unit and confirm technical orientation already given in certain critical areas. Plans called for delivery of the engineering model to NASA in mid-1979; ESA would deliver the flight unit to NASA in two shipments (in autumn 1979 and early 1980) to satisfy requirements of the first 2 Spacelab missions, scheduled for Dec. 1980 and Apr. 1981. (ESA Release Mar 6/78)

March 8: NASA announced the successful launch of *Landsat 3* (formerly Landsat-C), third of a series, from WTR at 12:54pm EST on March 5. Orbital parameters were: apogee, 913.96km; perigee, 897.3km; period, 103.108min; and inclination, 99.134°. Landsat was part of a U.S. program to develop remote sensing for improved earth resources management. The total program included development of remote-sensing instruments; data-analysis research using data from spacecraft, aircraft, and ground-truth sites; and a spaceflight program. *Landsat 3* carried two piggyback payloads, the larger (approximately 34kg) being a plasma-interaction experiment (PIX) by Lewis Research Center to measure plasma-coupling current and negative-voltage breakdown of a solar-array segment and a gold-plated steel disk. Objective of PIX was to establish design guidelines, materials, devices, and test methods for controlling detrimental interactions between high-voltage systems and the space-plasma environment. The PIX would remain attached to the second stage of the Delta vehicle. The second piggyback payload, the 27.3kg *Amsat Oscar* communications-relay satellite built by radio amateurs, ejected from the second stage approximately 12.3min after Delta separation from *Landsat 3*, would be available to amateur operators for science education, communications experiments, and search-and-rescue systems tests. The *Oscar D* carried two communications transponders having 1 to 2 watts of power output, and was magnetically stabilized.

Changes in the *Landsat 3* payload included alteration of the return-beam vidicon system to produce higher resolution panchromatic images for detailed ground mapping, and inclusion in the multispectral scanner (MSS) of a fifth band in the emitted terrestrial infrared radiation region. Objective of the MSS was to acquire multispectral high-spatial-resolution (80m) images of solar radiation reflected from earth's surface, emitted infrared-radiation images of 240m resolution, and panachromatic RBV images of 40m resolution. The MSS would obtain contiguous images about once every 18 days, weather permitting. The multispectral images would aid research and operations demonstrations in agriculture and forestry resources, mineral and land resources, land use, water resources, marine resources, cartography, and the environment. Applications would include surveying land use; measuring factors causing stress on crops and forest; inventorying crops and forests; assessing crop vigor and health; classifying areas by geological or geomorphic characteristics; delineating promising areas for mineral exploration; determining water-runoff patterns and extent of snowcover; monitoring population movements and environmental hazards to man; mapping sea ice; and analyzing shorelines. Demonstration projects called Applications Systems Verification and Transfer (ASVT), focusing on landcover inventory for federal, regional, state, and private users, would also use *Landsat 3* data.

The Landsat-C spacecraft (basically a Nimbus design modified to accommodate Landsat instruments and mission requirements) had the following parameters: weight, 90kg; mission margin, 51.4kg; stabilization type, 3-axis earth-oriented; stabilization accuracy, 0.7° pointing error, 0.04° per sec rate; average power available for experiments, 375 watts; thermal range, 10 to 30C; data storage capacity, 60min of video data (25.2 million bits). Launch vehicle was a 2-stage Thor Delta approximately 116ft long and 8ft in maximum body diameter. The first stage was a McDonnell Douglas extended long-tank Thor booster incorporating 9 strap-on Thiokol Castor II solid-fuel rocket motors; second stage was powered by the TRW TR-201 liquid-fuel pressure-fed engine gimbal-mounted to control pitch and yaw through second-stage burn. A nitrogen gas-system using 8 fixed nozzles provided roll control during powered and coast flight, as well as pitch and yaw control after second-stage cutoff. Two fixed nozzles fed from the propellant-tank helium-pressurization system provided retrothrust after spacecraft separation. Total cost of the Landsat program (excluding costs of the launch vehicles, and including tracking and data network-systems support) would be $43.9 million through 1979. (MOR E-641-78-03 [postlaunch] Mar 8/78, [prelaunch] Feb 22/78)

- MSFC had been responsible for a variety of ground tests around the U.S. to prove flightworthiness of the Space Shuttle's solid-fuel rocket booster, the center newsletter reported. Each Shuttle mission would use 2 of the 578 097kg (600ton) SRBs, 45.46 meters (149ft) long and 3.7 meters (12ft) in diameter, each providing 12 232 550 newtons (2.75 million lb) of thrust for about 2min from the launch pad to burnout and separation at an altitude of 45.3km (27mi). Tests at MSFC had put loads on a "short" version of the booster to duplicate load conditions encountered on the launch pad, in flight, during parachute deployment, and in water impact and recovery. Other MSFC engineers had tested the flight system designed to gimbal (or swivel) the motor nozzles at the lower end of each booster to guide the Shuttle on a proper course.

Engineers at United Technologies Corp.'s Chemical System Div. near San Jose, Calif., had tested 8 small solid-fuel booster-separation motors, fired simultaneously to separate each SRB and move it away from the Shuttle during flight. Each end of the two boosters would carry 4 motors, a total of 16 on each flight. These would have about 88 960 newtons (20 000lb) of thrust and would fire only about 1 sec each to accomplish separation. The separation motor had completed development testing; the Calif. test series would qualify it for flight.

Thiokol Corp.'s Wasatch Div. near Brigham City, Utah, had run full-duration full-thrust static firings on the SRB; high-speed sled runs in New Mexico had tested one phase of the SRB's parachute-recovery system (deployment of the pilot chute only) to see whether the nosecap of the system, when ejected, would clear the vehicle without becoming entangled; and the National Parachute Test Range at El Centro, Calif., had conducted airdrops of the entire parachute system. Other tests of SRB's electrical system and prelaunch checkout system were in progress. (*Marshall Star*, Mar 8/78, 4)

• NASA officials had unveiled the prototype of a parachute-cleaning machine strongly resembling a carwash operation, *Today* reported. If approved, the facility would become part of KSC's system to refurbish Space Shuttle parachutes. Each of the Shuttle's two solid-fuel rocket boosters jettisoned into the Atlantic Ocean shortly after launch would carry 4 nylon parachutes; both the boosters and the parachutes were designed for recovery and return to KSC for another launch. The carwash-type facility would rid the parachutes of salt water before washing and drying them in large machines. The current system had rinsed parachutes in the same water they were washed in; the new system would save some of the 20 000gal of water now used by the washing machine. In the carwash-type system, parachutes would move along an overhead rail, rinsed 3 times by water sent through high-pressure nozzles. The 3 main parachutes were 230ft long and 115ft in diameter, weighing 1600lb dry and 2000lb wet; the fourth parachute measured 145ft in length and 54ft in diameter, and would weigh 1200lb dry and 1400lb wet. On completion, the new system should require 2hr to wash and 2hr to dry each parachute. (*Today*, Mar 8/78, 8A)

• JSC announced plans for the week-long ninth annual lunar and planetary science conference focusing on the moon and other worlds, with the Lunar and Planetary Institute of Houston as co-host. Topics of presentations would include the formation of the solar system; new discoveries in moon rocks; the histories of planets; meteorites containing material from ancient stars; and comparative studies of Mars, Venus, and the earth. For the third consecutive year, the USSR would send a delegation. A number of topics would be emphasized: constraints on structures; composition and history of planetary interiors; characteristics and movement of material on lunar, planetary, and asteroid surfaces; characteristics and evolution of volcanic landforms; characterization and evolution of planetary crusts; nature and effect of impact processes; extraterrestrial materials; solar, interplanetary, and interstellar probes; and earliest history of the solar system. JSC had scheduled special sessions on industrial development of near-earth space, on origin of the solar system, on the future of planetary exploration, and on Mars and Mercury. (JSC Release 78-40)

• INTELSAT announced it had awarded the Yardney Electric Corp. of Pawcatuck, Conn., a $149 365 contract to develop an advanced nickel-hydrogen battery to demonstrate flight acceptance for use in future INTELSAT communications-satellite programs. The contract terms called for design, fabrication, testing, and delivery of two batteries by March 1979. INTELSAT had pioneered development of this technology, expected to improve energy density, increase cyclic capability, and prolong battery lifetime and reliability. (INTELSAT Release 78-6-I)

March 10: NASA announced receipt of the first 2 HiMAT (highly maneuverable aircraft technology) prototypes from the builder, Rockwell Intl., which developed the 0.44-scale version during a joint NASA-USAF multiphase competitive program. Flights of the subscale models at Dryden Flight Research Center would use the remotely piloted research vehicle (RPRV) technique developed there to test advanced aerodynamic technology for enhanced aircraft maneuverability. The RPRV offered a highly cost-effective means of flight testing advanced, high-risk technology without associated risks to test pilots. A pilot in a ground cockpit using telemetry, television, and radar air-launched unmanned craft from a carrier aircraft to fly them through maneuvers. (*DFRC X-Press*, Mar 10/78, 2; *AvWk*, Mar 20/78, 17)

• If the flight of *Soyuz 26* cosmonauts Yuri Romanenko and Georgy Grechko aboard *Salyut 6* space station continued to go well, they would establish a new space-duration record in the early morning of March 13, announced the Natl. Aeronautic Association, the organization maintaining official aviation and space records. The cosmonauts would surpass the previous record of 84 days set by U.S. astronauts Carr, Gibson, and Pogue aboard *Skylab 4* in 1973. The Soviets had not indicated when the mission would end. On Feb. 10 the *Soyuz 26* team equalled the previous USSR manned-spacecraft record of 63 days set by *Soyuz 18*. (NAA Release Mar 10/78)

March 13: NASA and ESA announced selection of experiments for the proposed 2-spacecraft solar-polar mission planned for launch in 1983 and designed for first-time observation of the sun from the unique perspective of its polar regions. The solar-polar mission would explore one of the remaining frontiers of the solar system: the third dimension of space, out of the plane of the orbits of the planets. All previous interplanetary space probes had flown in the orbits of the planets, essentially intersecting the sun's equatorial regions. Congress had not yet approved the project, but early selection of scientific participants and investigations would allow a prompt start on approval. NASA and ESA would each provide one spacecraft, and the combined scientific payload would be divided between U.S. and European investigators.

The Space Shuttle would launch both spacecraft simultaneously using an inertial upper-stage booster, directing them on a trajectory in the ecliptic plane (the plane containing all the planets) toward Jupiter. Swinging around Jupiter, the craft would use the gravity of that planet to move out of the ecliptic plane and back toward the sun in trajectories, one northbound and one southbound, essentially mirror images of each other. After passing over the north and south solar poles, the spacecrafts would swing through perihelion (the distance closest to the sun) in the ecliptic plane, pass respectively over the other solar poles, then fly back to the vicinity of Jupiter's orbit. The period from launch until shortly after the second pair of polar passages would be approximately 5yr.

The mission should provide important new knowledge about the solar wind, cosmic rays, and the 3-dimensional structure and evolution of the sun's corona (the outermost solar atmosphere), and increase understanding of solar phenomena that shape and control earth's space environment. In anticipation of a FY79 Congressional authorization of the mission, NASA's Jet Propulsion Laboratory, manager of the mission for NASA, had undertaken studies of the U.S. spacecraft, payload, and mission design concepts. More than 150 American and European scientists would participate in solar-polar investigations. (NASA Release 78-39; ESA Release Mar 13/78; JPL *Universe*, Mar 17/78, 1)

• NASA had mounted a "new effort" to make space applications the "administration's centerpiece," starting with a reorganization of applications management that could double that office's $283 million budget, *AvWk* reported. The new effort would include a major push for a "global information system" supported by all civilian earth-sensing spacecraft, to encompass all Landsat, Seasat, and environmental and meteorological satellite data, coordinated so that for any need an individual user could access all pertinent information available from space platforms. Theoretically, all space-derived information could some day come from a single distribution point.

NASA's effort would emphasize agency cooperation (NASA officials had met with representatives of the Depts. of Agriculture and Interior, EPA, and AID); management changes (a plan awaiting approval would remove flight projects from the traditional applications branches; the project offices would instead develop user-oriented sensor systems to be passed along to an applications-systems division, which would then reconfigure the sensors into the proper spacecraft format); center changes (instead of the previous lead-center approach to managing flight projects, NASA Hq would formulate programs as the main user liaison); applied sciences (greater emphasis by space applications on the phenomena its spacecraft would measure); ground systems (speedup of work on the end-to-end data system); an operational comsat system (solution of years-old Landsat operating problems); and communications research (industry would foster the research, while government agencies would concentrate on creating and sustaining a real market for public service communications). (*Av Wk*, Mar 13/78, 67)

• For the year ending Dec. 31, 1977, ComSatCorp reported consolidated net income of $32 499 000 ($3.27 per share) compared with $38 271 000 ($3.83 per share) for the preceding year. ComSatCorp said the volume of its services through the INTELSAT system and the contribution to net income by its wholly-owned subsidiary, Comsat General Corp., had increased substantially in 1977. ComSatCorp's leases of INTELSAT full-time half-circuits to its common-carrier customers had increased 19% between the end of 1976 and the end of 1977, and Comsat General's contribution to net income had increased from 16 cents per share in 1967 to 65 cents per share in 1977. These increases would have put 1977 net income ahead of 1976, except for the FCC proceeding challenging ComSatCorp rates for INTELSAT services.

The FCC's order to deduct from INTELSAT service revenue the amounts placed in escrow pending the outcome of the rate proceeding had adversely affected both 1977 and 1976 net income. The requirement had applied throughout 1977, but for only 6.5mo of 1976; the 1977 amount deducted from INTELSAT service revenue was therefore $37 779 000 more than that for 1976. ComSatCorp said its 1977 financial statements would reflect terms of a proposed settlement of the long-standing FCC rate proceeding. ComSatCorp management had agreed with representatives of the FCC general counsel and Common Carrier Bureau on the proposal, subject to approval by the FCC after an opportunity for public comment ending Mar. 30, 1978. Most of the settlement provisions related to current and future rates, and would affect operations results in 1978 and subsequent years. (COMSAT Release 78-8)

• A fundamental reappraisal by Western European governments of the overall European space effort had resulted in a demand by the West German government for more efficiency and better return on its investments in space, *Av Wk* reported. On hold during the debate were production of an initial batch of Arianes (European heavy launchers) and development of a new heavy telecommunications bus, as well as adoption of a broad new telecommunications package that would include the heavy bus. Meanwhile, determined to get more for its money, West Germany had begun exploring possible national or limited international programs outside the framework of ESA.

Industry sources said that West Germany, traditionally one of ESA's biggest contributors, was unhappy mainly because of repeated new beginnings of experimental communications-satellite programs as technological objectives changed. The Germans had wanted Europe to move directly into an operational comsat project after the successful launch and initial operations of the Franco-German Symphonie satellites. However, instead of building on this initiative, Western Europe (primarily through ESA) had taken up other experimental satellites like OTS (orbital test satellite), Marots (maritime OTS), and the H-Sat (experimental heavy telecommunications/multipurpose bus). West Germany, therefore, had begun thinking of developing independently (or more probably bilaterally) a direct-broadcast satellite that would be operationally feasible at home and commercially attractive abroad. (*AvWk*, Mar 13/78, 71)

March 14: Noise levels of Concorde departures at New York's John F. Kennedy Intl. Airport continued to be lower than those measured at Dulles Intl. Airport near Washington, D.C., according to the FAA's February monitoring report. On approach, average Feb. measurement was 98.7db at Cedarhurst on Long Island, compared with a cumulative average through Jan. of 100.4db. Vibration tests conducted by NASA during Feb. had shown the relationship between structural vibration and aircraft noise to be the same for Concorde as for other jet aircraft; the relatively higher levels of structural vibration measured during Concorde operations resulted from overall higher sound levels rather than from any unique characteristics of the Concorde. The FAA's monitoring equipment had recorded no sonic booms for the 103 Concorde operations during Feb. (FAA Release 23-78)

- JSC officials were puzzled after a weekend surprise, the *Houston Post* reported: 240 000 or so people came out to see the Shuttle orbiter Enterprise. With interest in the space program supposedly flagging, the question was why so many—some of whom walked for miles to get to the Space Shuttle orbiter—showed up to see an airplane-like craft just sitting atop a large airplane. The newspaper quoted a highway patrol trooper with 9yr of traffic-patrol duty: "Never in my life have I seen people come like that." Largest previous crowd had been the 135 000 who turned up at

Ellington Air Force Base for a 2-day Blue Angels show. Charles Biggs, JSC exhibits manager, said JSC had made no effort other than the usual press releases to attract a crowd, "no bands, no celebrities, no giveaways, just the orbiter sitting there." A tour guide commented: "What I think is that this is different than Apollo and going to the moon. I think the Shuttle is coming closer to the people. It is something they can relate to. They wanted to know when they can go on it." (*Houston Post,* Mar 14/78, 3A)

March 15: The *Marshall Star* reported that an MSFC researcher had been working to complete a weather experiment for the second Shuttle orbital flight test (OFT-2) scheduled for July 1979. His instrument, known as NOSL (nighttime-daylight optical survey of lightning), would obtain data on the many thunderstorms viewed by the Shuttle during a mission. The equipment consisted of a 16mm data-acquisition camera synchronized with a 2-channel cassette recorder, receiving the output of a photocell optical system serving as a sensor to pick up both visible and invisible lightning flashes and to record them as clicks on the tape.

Otha Vaughan, Jr., system developer, said he hoped to analyze the magnetic tapes containing cine photos and associated photo-optical data to get new insights into convective structure of cloud systems and lightning, the horizontal dimensions of lightning discharges, and possible electrical discharges that extend into the stratosphere. A successful experiment would permit adaptation of the data-acquisition and analysis technique to future meteorological satellites for identifying severe weather situations. (*Marshall Star,* Mar 15/78, 4)

• NASA announced it had judged the *UK 5 (Ariel 5)* mission successful in prelaunch objectives. This Explorer-class x-ray mission launched in 1974 had contributed significantly to x-ray astronomy and astrophysics. *Ariel 5*, a cooperative program between the U.S. and the U.K. Science Research Council, had discovered many new transient x-ray sources, although most of its studies were of steady x-ray sources. The second *Ariel 5* catalog had listed locations of 107 high-latitude x-ray sources, many of them extragalactic. The satellite had performed well, far beyond its 6mo design life, although gas for the attitude-control system had run out 2.5 yr after launch (18mo beyond prelaunch estimates). An onboard magnetic fine-torquing system had maintained attitude stability and allowed some spin-axis maneuvers. All 6 onboard instruments had performed as they did the first yr after launch and should continue to produce exceptional results. (MOR S-870-74-05 [postlaunch], Mar 15/78)

• NASA announced LeRC had awarded a $43 million contract to Detroit Diesel Allison Division of General Motors Corp. for support of the Dept. of Energy in development of ceramic materials, fabrication techniques, and components for new energy-efficient gas-turbine automobile engines. This extension through 1983 of an earlier contract would require use of special materials composed of elements available in abundance (such as silicon, nitrogen, and carbon) to be designed into components for gas-turbine engines; techniques to fabricate the components; and integration of the new components into advanced turbine-engine hardware. Allison Div. would test the components individually and in turbine engines, to verify the materials and the improvements needed to realize significant savings in fueling gas-turbine engines as well as to reduce costs of engine production. (NASA Release 78-43)

March 17: NASA announced it had selected four 2-man crews to begin training for Space Shuttle orbital flights. Those chosen were John Young, commander, with Robert Crippen, pilot; Joe Engle, commander, with Richard Truly, pilot; Fred Haise, commander, with Jack Lousma, pilot; and Vance Brand, commander, with Charles Fullerton, pilot. Young and Crippen would crew the first orbital flight test (OFT-1) scheduled for launch in spring 1979 from KSC, with Engle and Truly as backup.

NASA had planned 6 orbital flight tests increasing in complexity to check out the first U.S. reusable spacecraft. On the first 4 flights, the 75-ton orbiter would make an unpowered landing on a dry lakebed at DFRC; thereafter, it would return to a specially constructed runway at the KSC launch site. NASA had also considered an OFT mission to boost Skylab into a higher orbit; prime and backup crews to implement such a plan would be selected from those already named. (NASA Release 78-44; JSC Release 78-15; *DFRC X-Press,* Mar 24/78, 4; *JSC Roundup,* Mar 31/78, 1)

• Pioneer Venus, scheduled for launch May 20, would carry a recently completed JPL instrument to obtain new weather information on Venus, *JPL Universe* reported. VORTEX (Venus orbiter radiometric temperature experiment), a $4.5 million co-effort of JPL and Oxford Univ., England, would collect close-up data on winds, cloud structures, water vapor, and temperatures of Venus. Using technologies developed for satellite monitoring of earth weather, VORTEX would report 3-dimensional measurements of the Venus atmosphere. The complex instrument, an 8-channel radiometer combining 4 different sub-experiments (three separate radiometers and a spectrometer) would weigh only 12 lb, partly because of the special hybrid microelectronics used. Orbiting as close as 100km above the cloudtops, it could "see" weather conditions at 7 different levels or layers. For a full Venus year of 243 days, scientists would process VORTEX data into weather maps and infrared images and compare meteorological conditions on Venus with those on earth. (*JPL Universe,* Mar 17/78, 2)

• NASA announced appointment of Neil Hutchinson, Charles Lewis, and Donald Puddy, all of JSC's Flight Operations Directorate, as flight directors at JSC for the first manned Shuttle-orbital flight, to plan and direct activities of the Mission Control Center during real-time Shuttle operations. They also would be responsible for integrating inputs from all elements of NASA, contractors, and the scientific communities. Hutchinson would manage all activities associated with the Shuttle-ascent phase; Lewis, the on-orbit phase; and Puddy, the orbiter reentry phase. All had served as flight directors during Apollo and Skylab missions. (JSC Release 78-16; *JSC Roundup,* Mar 31/78, 1)

• KSC's *Spaceport News* noted the 20th anniversary of the launch of *Vanguard 1,* a satellite which, together with *Explorer 1,* launched 6wk earlier, "invoked a national sigh of relief." Project Vanguard had begun in July 1955 with a White House announcement that the U.S. would launch a satellite as the U.S. contribution to the International Geophysical Year. The first attempt to launch a Vanguard, TV-3, ended when the spacecraft was destroyed Dec. 6, 1957, in an explosion on the pad. As one observer stated, "Following the explosion of TV-3, the Vanguard became a whipping boy for the hurt pride of the American people." Then came the success of *Explorer 1.* But the failures of the next Vanguard and next Explorer meant tremendous pressures on the Vanguard launch team. *Vanguard 1* had been launched from Cape Canaveral at 7:15am, March 17, 1958. The Vanguard team had in record time (2yr, 6mo, and 8da) developed from scratch a complete high-performance 3-stage launch vehicle, a highly accurate worldwide satellite-tracking system, and an adequate launch facility and range instrumentation. And, they had suceeded in getting the Vanguard into orbit during the International Geophysical Year. (*Spaceport News,* Mar 17/78, 4)

• Many significant technological advances of the past decade should be credited to NASA, said the *Lewis News*, quoting an article by Dr. Wojciech Rostafinski, an engineer in LeRC's Fluid System Components Division and frequent NASA spokesperson on Voice of America broadcasts, in the *Cleveland Plain Dealer*. The article continued: "The magnitude and importance of NASA-derived technology benefits have already been reported. Broadly, payoffs from technology transfer are direct and indirect. One direct benefit is satellites that report on weather, pollution, and crops. . . . An example of indirect benefits—the so-called spinoffs—is the electronic circuit miniaturization, so widely adopted today by terrestrial computer and calculator designers. Countless other innovations could be given for both categories.

"Now a question arises concerning the monetary return on the investment. In other words, why should we continue to spend large sums of money on 'obviously' abstract endeavors in space? . . . Let us check the figures. Since 1958, when NASA was created, in the span of a short (or long, depending on the 'yardstick' by which the time is measured) 20 years, NASA spent a total budget of $67.8 billion. This relatively lofty figure does not appear high at all when compared to other expenditures of the federal government. NASA appropriations have represented, on the average over the years, only 1.8% of the federal budget; in the last five years this has been down to 1%. Currently, NASA accounts for only 0.85% of the budget. Making a parallel with the budget of a family whose income is $20 000 a year, last year's NASA appropriation represents $170 per year set aside as investment. Not a large figure; a small one, actually, when compared to today's car prices, utility bills, or to the cost of eduction. . . .

"In 1971, Midwest Research Institute, studying the impact of technological activity, concluded that the $25 billion NASA spent in its first ten years had returned $52 billion through 1970 and by 1987 will have returned $181 billion. Five years later, Chase Econometrics also studied the economic impact of NASA R&D and concluded that an annual increase in NASA spending of $1 billion for the 1975-1984 decade would increase the GNP $23 billion by 1984; $23 billion for $10 billion during ten years . . . .

"Summing up, it becomes obvious and clear that it is much cheaper and wiser to seek technological progress through rational research, federally organized and performed by government and industry. The return on such investment is sound. The relatively modest sums invested in the national aerospace programs entrusted to NASA are well spent." (*Lewis News,* Mar 17/78, 1)

- Rockwell Intl. Corp. announced that the Air Force Flight Dynamics Laboratory had awarded its Los Angeles Division a $6.04 million contract to build test-aircraft structures using a revolutionary manufacturing process developed by the company and used on the Rockwell-built Space Shuttle. The AF Built-up Low-cost Advanced Titanium Structure (BLATS) program would use 2 Rockwell-developed processes (diffusion bonding and superplastic forming) in designing, fabricating, and testing a 1000lb section of fuselage for use on a future advanced fighter. The 46mo contract called for construction of a complex about 8ft × 10ft × 3ft, representing the center fuselage section where the wings attach, and a portion of the aft fuselage where the engines would be mounted, and including the necessary fuel tanks.

Rockwell engineers believed superplastic forming with concurrent diffusion bonding of titanium aircraft structure was the biggest breakthrough of the decade in advanced metals fabrication, because it might result (depending on the type of structure) in cost savings of from

50 to 70% and weight savings of from 30 to 50%, compared to conventional methods of building titanium parts. Besides the next generation of fighter aircraft, other applications of the process could be jet engines, spacecraft, and supersonic transports. (*Rockwell Release* LAD-8)

March 20: Ames Research Center announced the scheduled arrival this month of the XV-15, a tilt-rotor research aircraft, which would have wingtip-mounted turbine engines that turned 7.6m (25ft) prop rotors. The engine-prop rotor assembly could be tilted up for helicopter-type vertical takeoff and landing, or oriented forward in the normal position for conventional flight as an airplane. Bell Helicopter Textron, Fort Worth, Tex., had built the aircraft under a joint program of ARC and the U.S. Army's Research and Technology Laboratories at Moffett Field, Calif. The first XV-15 to arrive at ARC, modifed for remote control, would undergo 6wk of testing in ARC's 12.2 × 24.4m (40 × 80ft) wind tunnel. Flight test of the second aircraft would begin at the Bell facilities in Fort Worth after wind-tunnel tests. ARC would eventually house both aircraft for Army/NASA evaluation of the tilt-rotor concept, and for ARC research on terminal-area (airport) navigation and on vertical- and short-takeoff-and-landing. (NASA Release 78-45)

• The U.S. Army had devised a charged-particle beam weapon using negative hydrogen neutralized through an exchange cell as an antisatellite-kill mechanism, *AvWk* reported. The program had been code-named Sipapu, an American Indian word meaning sacred fire. Its application to ballistic-missile defense would be as an accelerator with small angular divergence; an antisatellite version with a range of several thousand km could destroy enemy vehicles without maneuvering to intercept. *AvWk* said that a smaller adaptation of the device, requiring lower power levels, could be orbited in 2 or 3yr, probably by NASA's Space Shuttle.

The Accelerator Div. at Los Alamos Scientific Laboratory had worked on Sipapu for the Army, with USAF participation; the Army's Ballistic Missile Defense Command would spend $4.3 million this year and $5 million in FY79 for charged-particle beam weapons, and $3 million in the coming yr for high-energy laser weapons. (*AvWk*, Mar 20/78, 13)

• The USAF had sent a destruct signal Mar. 19 to a Titan rocket carrying a pair of military comsats, the *W Post* reported, aborting an $80-million mission 8min after liftoff from Cape Canaveral. Air Force officials said a range-safety officer had sent the destruct signal when the rocket suddenly began slowing down and falling back to earth. Debris from the 31 000lb space mission, rocket, and satellites had fallen into the ocean, although the exact location was unknown. (*W Post*, Mar 20/78, B-9)

March 21: The *NYT* reported that the Soviet Union had built and bombers drop-tested a new manned space vehicle similar to the U.S. Space Shuttle. The delta-winged reusable vehicle had been dropped from a Soviet Tupolev TU-95 Bear bomber in atmospheric tests of the spacecraft's aerodynamic and handling qualities, like recent tests of the Space Shuttle. No known space testing of the delta-winged vehicle had occurred, although the Soviets might have begun orbital tests with a second new manned-flight craft with space-tug capabilities. Design characteristics of the test vehicle were apparently similar to those of both the U.S. Shuttle orbiter and the lifting-body research vehicles flight-tested earlier by the U.S. Air Force and NASA. The vehicle strongly resembled the USAF/Boeing X-20 DynaSoar concept, which had been viewed as a space station resupply vehicle before the program was canceled. The Soviet spacecraft was described as smaller than the 150 000lb NASA Shuttle orbiter, but larger than the Soyuz expendable manned transport. The *NYT* said the new vehicle indicated the USSR believed it had the technology to proceed with building reusable manned spacecraft. (*NYT*, Mar 21/78, 12)

March 22: LaRC announced it had begun a research program on problems of agricultural aircraft. Beginning in 1921, airplanes for agricultural use had required conversion from some other purpose; in 1950, the first aircraft was designed specifically for agricultural use. Agricultural aircraft had improved since then, but still relied on 1940s technology. The aerial-applications industry had recognized this, and asked NASA to study drift, swath guidance, liquid and dry material-distribution systems, and aircraft-handling characteristics causing pilot fatigue. The NASA study would also attempt to make the wake vortex of an airplane work for, rather than against, aerial applications. Aerodynamic concerns involved reducing drag for better fuel efficiency and developing appropriate high-lift concepts to improve takeoff, landing, and turning performance.

LaRC would conduct the study at its vortex-research facility, its full-scale wind tunnel, and in actual flight tests. The vortex-research facility would test small-scale models of the agricultural aircraft for interactions of the aircraft wake with dispersed spray and granular materials. The full-scale tunnel and flight tests would use an Ayres Thrush S2R-800, one of the largest agricultural aircraft. (LaRC Release 78-130)

• The *Marshall Star* reported that a NASA decision to boost the Skylab space station to a higher orbit could lead to reactivation and use of Skylab's onboard systems and instruments in a number of useful projects. MSFC had awarded parallel study contracts, each in the amount of $125 000, to Martin Marietta Corp. and McDonnell Douglas Astronautics Co. for independent reports on the possibilities and benefits of Skylab reuse. The 9-mo studies of the most effective ways to use Skylab in further missions, experiments, and demonstrations would concentrate on the experiments or equipment already aboard Skylab, for firsthand evaluation of how materials and equipment were affected by 10 or more yr in space; on crew quarters and other support, for Spacelab missions and experiments that could benefit from long duration and an additional energy supply; and on opportunities offered by the Skylab in itself, or in conjunction with other hardware elements, for new missions or experiments. For example, the relatively large facility (comparable to a 3-bedroom home) might provide a convenient platform for fabricating and constructing large space structures, or could aid in converting such structures into useful demonstrations or operational systems.

The ground station in Bermuda had begun operations Mar. 6 to 13 to reactivate Skylab, turning on command and telemetry systems and receiving data. Transfer of power from the airlock module to the Apollo telescope mount permitted reception of telemetry; the ATM solar arrays also provided power when turned toward the sun. Data received from the ATM computer indicated it was in good working order and had enough power. On Skylab's last working pass, controllers had used about 11min to check the status of the trickle charge to batteries 2, 4, and 5; the charge had been turned off on battery 7, which had remained fully charged and ready for the next mission. Controllers also had performed some systems checkoffs, Bermuda reporting the command receiver as strong throughout the pass. Plans were to reactivate Skylab in mid-April, using the TAC system to reduce atmospheric drag and prolong Skylab's orbital lifetime for several months. (*Marshall Star,* Mar 22/78, 1)

March 23: LaRC announced award to Micro Craft, Inc., Tullahoma, Tenn., of a contract to design and build precision models for wind-tunnel tests at the center. The small-scale models of controlled shape and finish, designed specifically for research and development projects, would consist of metals, moldable or formable materials, fiberglass-reinforced resins, woods, or combinations. The contract might also require specialized model-support equipment and other unique items needed for model tests. Micro Craft estimated the value of the 3-yr, cost-plus-fixed-fee contract at $2.8 million. (LaRC Release 78-14)

• NASA's Scientific and Technical Information Office announced publication of a 276-page summary, *The Search for Extraterrestrial Intelligence,* of the findings of a blue-ribbon group of 16 U.S. scientists on detecting possible radio signals from intelligent life in the universe. Based on the results of a series of SETI (search for extraterrestrial intelligence) workshops held during 1975 and 1976, the summary had 3 sections: Consensus, Colloquies, and Complementary Documents, covering subjects like preferred frequency bands, search strategies, and scanning devices used on radio telescopes. "Consensus" at the beginning of the book reviewed the conclusions reached by the SETI group: a serious search for extraterrestrial intelligence was both timely and feasible; a significant SETI program with potential for secondary benefits could be undertaken with only modest resources; large systems of great capability could be built; and SETI was intrinsically an international endeavor in which the U.S. could take a lead. NASA's proposed FY79 budget contained a request for $2 million for JPL to start the SETI program in Oct. 1978 and run it for 5yr. The funds, if approved, would be for an all-sky all-frequency search for radio signals from intelligent extraterrestrial life, using existing antennas of the Deep Space Network at Goldstone, Calif., and state-of-the-art hardware including a new very-wide-bandwidth supercooled preamplifier to be developed specifically for the effort. (ARC *Astrogram,* Mar 23/78, 1)

• NASA announced that the governors of Washington, Idaho, and Oregon had unanimously agreed to participate in a 3yr program demonstrating the use of NASA-supplied satellite data for natural-resources management in their states. Governors Dixy Lee Ray, John Evans, and Robert Straub, together with federal representative Pat Vaughan, constituted the Pacific Northwest Regional Commission. They voted $480 000 from commission funds to support first-yr activities beginning in Apr. 1979. The 3-yr plan would be a follow-up of the Land Resource Inventory Demonstration Project launched by the commission in 1975 during which more than 45 state and local agencies in the 3 states had used satellite data for surveys and inventories of various landcover types. Continuing the program would provide the state agencies doing planning and natural-resource management with an operational capability of extracting and using information from NASA's Landsat satellite system, and would aid them in using the more sophisticated data from Landsat-C after its launch. The Pacific Northwest program would join others across the U.S. sponsored by NASA's Office of Space and Terrestrial Applications demonstrating the use of space technology by state and local governments, businesses, and universities. (ARC *Astrogram,* Mar 23/78, 2)

March 24: DRFC reported that 5 of its employees had received NASA's Exceptional Service Medal for outstanding work on the Shuttle approach and landing test (ALT) program. The employees received the awards at JSC, where the Boeing 747 carrying the Shuttle orbiter had stopped on its way to MSFC.

Receiving medals were Fitzhugh Fulton, for "outstanding piloting skill and technical expertise as aircraft commander of the Shuttle Carrier Aircraft (SCA) during the Approach and Landing Test Program"; Tom

McMurtry, for achievements as first officer of the SCA "which contributed significantly to the accomplishment of all major flight objectives during the ALT program"; Vic Horton, for "personal dedication and technical expertise" including "design, development, testing, and installation of a unique crew egress system for the SCA"; Bill Andrews, for "an efficient and successful test team that was fully prepared to support the ALT flights"; and John McTigue, for effectiveness "in managing the overall support plan and in resolving technical, organizational, and resource problems as they developed." (DFRC *X-Press,* Mar 24/78, 2)

March 27: NASA and the Dept. of Energy announced they had signed a joint contract with Mechanical Technology, Inc., Latham, N.Y., to develop and test 3 generations of the Stirling engine for passenger cars. Produced earlier by United Stirling of Sweden, the baseline engine would be the hardware starting point for improving automotive fuel economy, performance, reliability, weight, and cost. The Stirling engine offered potential high fuel efficiency, flexibility in choice of fuels, inherently low noise and low pollution, and good driving characteristics. (NASA Release 78-48; DOE Release R-78-104)

• George Mueller, NASA's associate administrator for manned spaceflight 1963–1969, now chairman and president of Systems Development Corp., was named president-elect of the American Inst. of Aeronautics and Astronautics, *AvWk* reported. He would serve on the AIAA board of directors during 1978 and be inaugurated as president in 1979. (*AvWk*, Mar 27/78, 11)

• INTELSAT announced award of an international research contract valued at $75 380 to Cable & Wireless, Ltd., London, to determine the effects of rain on comsat radio signals. C&W would obtain annual statistics for rain-caused depolarization at 4GHz frequencies by measuring the relative amplitude of the 2 orthogonal circular-polarized components of a satellite signal. INTELSAT would use results to develop transmission and reception techniques that could double the capacity of its international telecommunications satellites. (INTELSAT Release 77-8-M)

March 28: KSC announced it had awarded the Univ. of Florida a $99 013 contract for development of a water-management system using satellite data and other NASA-developed technology. A Florida water-resources management information system could provide managers with a computerized bank of information to help meet increased demand for water; data from earth-resources satellites like NASA's Landsats and NOAA's Goes should reduce guesswork in water management.

Studies by the Univ. of Florida and the South Florida Water Management District had substantiated Florida's need for a comprehensive water-management system. The university study showed lack of water as the main problem facing Florida agriculture, and reported that water demand would equal the existing supply by about 1980. These studies, coupled with a 1972 mandate by the Florida legislature for a water-use and supply development plan, prompted state water-management districts to seek help from the university and KSC in solving their problems. (KSC Release 32-78)

March 29: The *Marshall Star* reported on a unique suspension system that would use air bags and cables to hang the Space Shuttle's orbiter Enterprise and its external tank in the test tower, for the first phase of 1978 ground tests scheduled to begin in Apr. The system would consist of a large overhead truss fitted with air bags and cables, installed like a crossbeam at the 65.8m (216ft) level between two walls of the tall test stand. Although the orbiter and external tank would weigh about 544 320kg (1.2 million lb), the suspension system would allow the freedom of movement needed to obtain test data. Suspension of the orbiter and tank in this first phase of testing would duplicate as nearly as possible the flight conditions of the Shuttle at high altitudes, after the solid rocket boosters drop off at 43.5km (27mi) 2min into the mission. Later tests of the entire Shuttle assembly would use a different suspension system.

The first Shuttle test phase would begin with the external tank temporarily fastened by knee braces to the stand, the orbiter lowered into place and mated as it would be for an actual flight. With the orbiter in place, engineers would install the suspension system overhead, attach cables from the air bags to the external tank, and remove the knee braces so that the cables would take the weight of the orbiter and external tank; lateral restraints would prevent sideways movement. The design of the truss, 25.3m (83ft) long and weighing 63 504kg (70 tons), would permit less than 2.5c (1in) deflection when fully loaded. Supporting members were of high-strength steel. (*Marshall Star,* Mar 29/78, 4)

March 30: Nature magazine quoted Aleksey Leonov, deputy head of the Soviet Space Training Centre, as saying that plans were final for the next 2 Eastern Europe cosmonauts – a Pole and an East German, each with a Soviet companion – to go into orbit "before the end of the year." Representatives of other socialist bloc countries (including Cuba and Mongolia) had arrived at the Gagarin Space Centre to train for flights "before 1983" furthering socialist cooperation in space. The scientific (as opposed to the symbolic) value of such participation would clearly vary from country to country, the article said: Cuba and Mongolia, for example, would contribute mainly by providing tracking facilities rather than new science. Czechoslovakia, however, had made scientific contributions; Czech microbiologists had provided special Chlorella strains, including mutations derived from chlorophyll, that for the first time demonstrated active growth, previously retarded by space conditions. Although Chlorella experiments had been performed on *Salyut 4* and at an earlier stage of the *Salyut 6* mission, the unique collection of strains produced in Czechoslovakia had exhibited considerable difference. (*Nature*, Mar 30/78, 394)

March 31: GSFC announced it would welcome a first group of guest astronomers Apr. 3 to its international ultraviolet explorer (IUE) satellite observatory, the first designed so that astronomers with little knowledge of spacecraft design and orbital operations could walk in, conduct observations, and receive data within 24hr. Astronomers would use NASA's *IUE*, placed in a modified synchronous earth orbit Jan. 26, to examine a wide range of celestial objects in the spectral ultraviolet region between 1150 and 3200A that included emissions of many common elements such as hydrogen, helium, carbon, nitrogen, and oxygen. Studies would range from the solar system to distant quasars, pulsars, and black holes.

NASA had selected nearly 200 astronomers from 17 nations (including the USSR) to conduct observations from GSFC's *IUE* installation and ESA's facility near Madrid, Spain. First guest astronomers would be Dr. Jeffrey Linsky, Univ. of Colo. specialist in cool stars, and Dr. Sara Head of GSFC, a specialist in hot stars. They would be succeeded by groups of 3 or 4 on a 7-day-a-wk basis throughout the yr. After 45 scientists had completed data reduction, the information gathered would indicate which aspects of astronomy should be emphasized during the spacecraft's remaining lifetime. (NASA Release 78-50)

- JPL announced that aerospace and aircraft design engineers from the U.S. and Europe would meet for the 12th Aerospace Mechanism Symposium (AMS) at ARC late in Apr. The symposium would be devoted to discussion of problems of design, development, and use of aerospace and aircraft mechanisms. Featured banquet speaker would be Dr. P.B.S. Lissaman, one of the designers of the Gossamer Condor, the ultralightweight and most successful manpowered aircraft built to date (*JPL Universe*, Mar 31/78, 1)

- The *JSC Roundup* reported on a 2-day conference, "Meeting Our Energy Needs Today and Tomorrow," with Dr. Peter Glaser, commonly thought of as the initiator of the solar-power satellite concept, as featured speaker. Glaser, designer of three instruments deployed on the lunar surface by the Apollo astronauts, had proposed a solar-power-satellite concept in 1968 before the days of concern with an energy shortage. He said the scientific community had slowly become aware that solar energy "shines brighter than ever as the major energy source."

Glaser summarized the advantages of collecting the solar energy constantly available in space, as opposed to disadvantages of any terrestrial energy source: absence of gravity and weather; avoidance of thermal pollution and waste; and the ability to direct a beam of collected energy to any location on earth, sunny or not, having usable land or not, close to the user or not. Solar-energy development would depend on development of the Space Shuttle, he noted, and was an idea becoming economically attractive and socially acceptable. Microwave and laser beams could transmit this energy to earth; directing a microwave beam accurately had been demonstrated. As for safety, Glaser pointed out that one cannot concentrate microwaves into a weapon system, whereas lasers could be lethal, so that all nations would have to agree that the laser method would never be used as a weapon. Glaser described the phased-array transmitting antenna already constructed on a 5-story-high project in the Aleutian Islands. He estimated 84% solar-power satellite efficiency in producing 30kw of power, as compared to current power plants with an efficiency range of about 40%. (*JSC Roundup,* Mar 31/78, 4)

- NASA announced that MSFC had developed a teleoperator-retrieval system (TRS) vehicle for first use in late 1979, either to boost the Skylab orbiting space laboratory to a higher orbit or to deorbit it in a remote ocean area. The decision to reboost or deorbit was expected early in 1979. Concept of the system evolved from teleoperator supporting research and development under way since the mid-1960s. Anticipated long-range usefulness of the TRS for payload survey, stabilization, retrieval, and delivery missions; its recovery and reuse capability; and its adaptability for the Skylab reboost/deorbit mission had led to its further development.

The TRS had a central-core propulsion system accommodating strap-on kits for additional propulsion. A 24-nozzle attitude-control system on the core provided 6 deg of freedom for control of the vehicle during rendezvous, docking, and initial orientation. Although thrusters originally used cold-gas propulsion, designers were studying use of low-cost hydrazine (hot gas). Preprogrammed instructions in the vehicle's core and computer, or a Shuttle crew member, would control guidance and attitude maneuvers. The TRS and orbiter structure were new designs; other systems would be fabricated almost completely from either off-the-shelf components or those being developed under NASA contracts. (NASA Release 78-49)

- Although to most people "aviation" would mean airliners and military aircraft, with a sprinkling of light planes, most of the aircraft in service and about two-thirds of the miles flown were in branches of flying known collectively as "general aviation," *Lewis News* reported, including private ownership for travel or sport; air taxi and commuter operations;

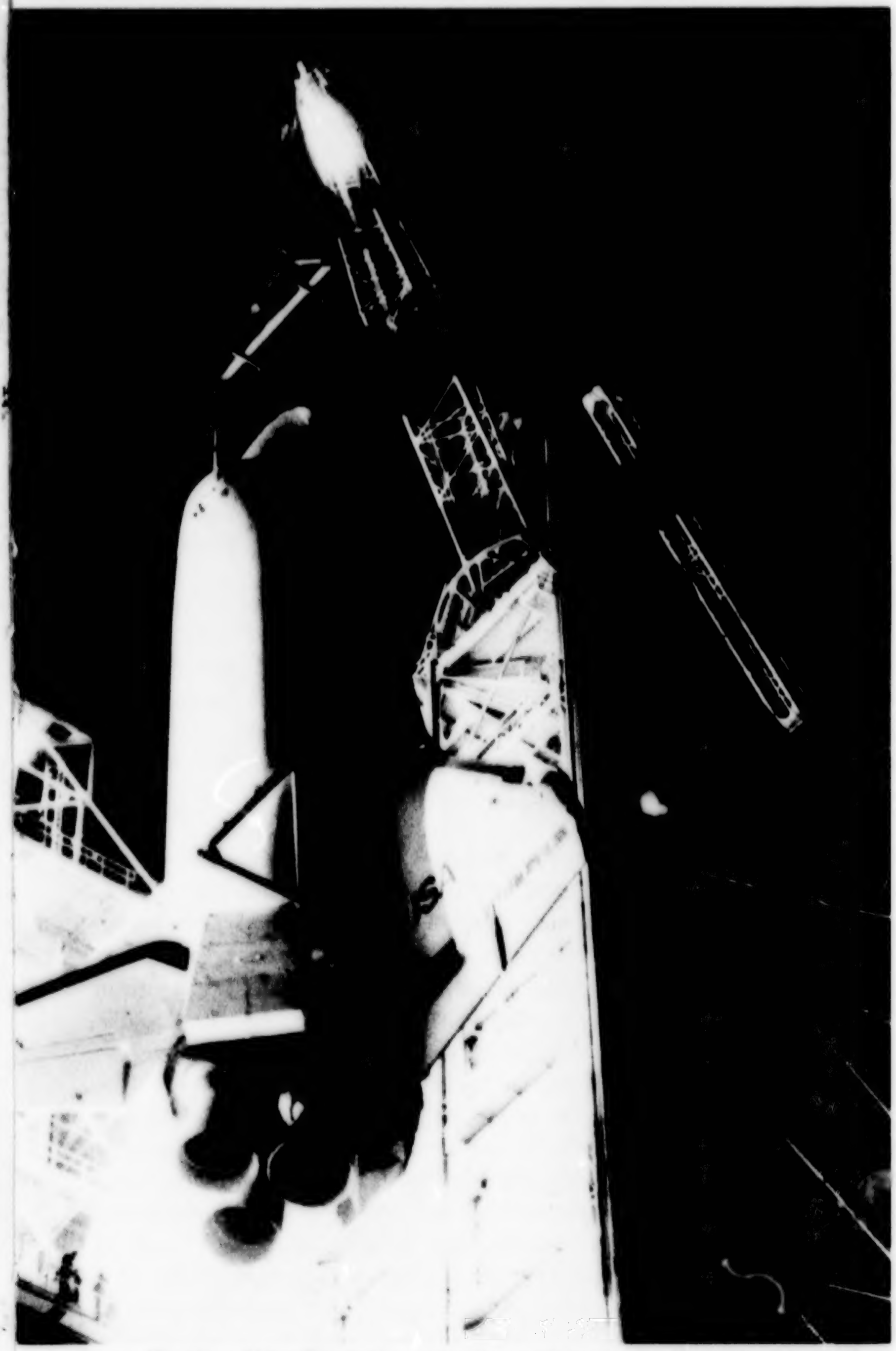
agricultural flying; prospecting and exploration; law enforcement; firefighting; air ambulance; and pilot training. About 230 000 aircraft of varied types did jobs in the Free World, more than 90% of them in the U.S. General aviation had served all 13 200 U.S. airports, compared to the airlines' 42%.

In 1977 general aviation had provided transportation for 100 million Americans, using less than 0.7 of 1% of all fuel used for transportation in the U.S. and less than 6% of fuel used by all aviation, while carrying a third of all intercity air passengers. The general aviation industry had provided jobs for more than a quarter of a million Americans in the manufacture, sales, and service of its products; grossed about $1.5 billion in new aircraft sales; and exported about 30% of its total production, contributing more than $500 million to the U.S. balance of trade. (*Lewis News,* Mar 31/78, 3)

During March: NASA announced arrival of the Space Shuttle orbiter, external tank, and solid-fuel rocket booster at MSFC for first assembly as a complete vehicle for ground-vibration tests. Using a facility originally designed for Saturn V moon-rocket testing, engineers would begin in early spring to evaluate the structural dynamics of the assembly and their effect on the Shuttle's system. The mated vertical ground-vibration tests would consist of "floating" the Shuttle in the tall test tower and applying vibrations with exciters powered by amplifiers similar to those found on home stereo sets; sensors on the skin would record characteristics of the vibrations passing from one area to another. The resulting data would verify system-design and mathematical models of the control-system's reaction to severe vibrations expected during launch and flight into orbit.

The first test-article configuration would include an orbiter and external tank to simulate the high-altitude portion of a mission after separation of the boosters. The second test configuration would consist of solid-fuel rocket boosters filled with inert propellants, stacked in the stand along with the orbiter and tank to simulate liftoff conditions. The third test configuration would be the same as the second, except that boosters would be empty, simulating a mission just before booster separation. Tests would continue through most of the year stopping only to change test configurations. (NASA Release 78-47)

- GSFC reported it had asked industry to build a computer that could process satellite images 10 to 100 times faster than present machines. The new computer would be based on 6yr of research in "massive parallelism," consisting of 16 384 processors working together, each processor a simple computer, with a single chip of silicon probably carrying 2 processors. Previous machines had not gone beyond a web of 64 simple computers. The new system would cross-correlate landmark images from earth-watching satellites 100 times faster than present



Space Shuttle orbiter Enterprise, assuming position in the dynamic test stand at MSFC where it would undergo vibration testing from May to November 1978. (NASA photo 78-H-222)

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machines, making multispectral classifications (such as distinguishing wheatland from cornfields) and geometric corrections for comparison of pictures taken from different vantage points in one-tenth of the time previously necessary. (*Goddard News,* Mar 78, 3)

• Administrator Robert Frosch said NASA would analyze any chemical samples of UFOs received from credible sources but would not initiate any research programs, *Goddard News* reported. Frosch outlined NASA's position in a letter to the White House, in response to an inquiry from the director of science and technology policy. NASA was most often asked about the purported UFO sightings by astronauts and President Carter; NASA had satisfied itself that the astronauts had seen nothing abnormal in the space environment, and the bright object President Carter reported seeing in the sky when he was governor of Ga. had been classified as "unidentifiable" by the Natl. Investigations Committee on Aerial Phenomena. Some students of astronomy had suggested that what Carter saw was the planet Venus, at times much brighter than a first-magnitude star.

Although the USAF had routinely investigated reports of all UFO sightings until 1969, when it terminated its "Project Blue Book," it now limited its interest to sightings important to defense surveillance. The Air Force had concluded that never in almost 2 decades of investigating UFOs had it found "evidence of technological developments . . . beyond the range of present-day scientific knowledge." (*Goddard News,* Mar 78, 3)

• The Natl. Research Council reported that, at the request of NASA, a committee had reviewed potential uses of microwave sensors to supplement or replace visible-light and infrared detectors for earth-resource surveys from space. The committee had evaluated the potential of microwave sensors to penetrate cloudcover and possibly vegetation cover, to operate day and night, to detect soil moisture, to measure distance, and to aid in geological mapping; sensors specifically studied were synthetic-aperture radar and passive radiometers.

In a letter accompanying the report to NASA, committee chairman Arthur Anderson of IBM wrote: "The Committee concluded that an adequate experimental data base was available to support the initial development of an experimental radiometer sensor system (passive microwave sensor) for soil moisture, subsurface phenomena, and salinity measurements and a single-frequency single-polarization radar for geological explorations as shuttle experiments. The Committee did not feel that an adequate experimental data base was available to support the initial development of a multifrequency multipolarization radar for soil moisture measurements and vegetation or crop classification purposes." (NRC newsletter, Mar 78, 8)

- The Carter administration had submitted to Congress a $126 billion budget request for the Dept. of Defense, a 22% increase over last year, the Natl. Aeronautic Association newsletter reported. The $12 billion requested for procurement of 733 aircraft and helicopters was higher than last year, but the bill had asked for 34 fewer fixed-wing aircraft. Missile procurement dropped to $4 billion for 18 860 missiles, compared to 41 674 in FY78; military R&D was up to $12.7 billion. Higher personnel costs would consume more than half the budget. Civil defense at $100 million was the same as last year. The budget had forecast a 6.1% inflation factor, allowing for 2% growth over FY78. Except for the previously announced B-1 decision, the budget did not kill any major ongoing weapons-development programs. (NAA newsletter, Mar 78, 1; AFSC *Newsreview,* Mar 78, 2)

- The Natl. Academy of Sciences released a report of the ad hoc committee for review of the Space Shuttle main-engine development program. This review was requested by Senators Adlai E. Stevenson (D-Ill) and Harrison L. Schmitt (R-NM) in Dec. 1977 as an independent assessment by Natl. Research Council of the safety of the main engine during both orbital-flight and operational phases of the Shuttle program. The review was to be completed by the end of Feb. 1978 for consideration during FY 1979 NASA authorization hearings.

The committee reported that it saw "no reason to suggest that a safe and reliable main engine cannot be developed ultimately for the manned orbital flight tests and the later operational flights," but submitted a number of recommendations: first, since the flight schedule was not ready yet, the critical milestones should be reviewed later in 1978. Other recommendations included allowance of "adequate time to analyze root problems . . . rather than selecting technical 'fixes' to sure symptoms," as well as a complete tear-down inspection of the main engine after the first and sixth flights (which had not been envisioned in the schedule).

At a March 31 hearing before the Senate subcommittee on science, technology, and space, with Sen. Stevenson as chairman, Dr. Eugene E. Covert of the NRC described the ad hoc committee's activities and the reasons for its recommendations, expressing appreciation for the cooperation of NASA and its contractors during the review. Dr. Robert A. Frosch, NASA administrator, then summarized "the NASA reaction" to the report and its recommendations; Sen. Stevenson commended NASA's prompt and positive response, but proceeded with further questions on schedule and funding. In addition to NASA staff (including associate administrator John Yardley, MSFC engine project manager J.R. Thompson, Shuttle program director Dr. Mike Malkin, and deputy director Roy Day, and comptroller William Lilly), the Rocketdyne engine project manager Dominic Sanchini was on hand to explain administrative and technical problems encountered with the main engine.

The Senate committee report would contain all the testimony, the text of the ad hoc committee report, and further information on specific questions asked by Sen. Stevenson. (Text, hearing report 95-87, Sen Comm Cmte Mar 31/78; "Technical Status of the Space Shuttle Main Engine," Natl Res Cncl, March 78)

April

April 1: The *NYT* reported that the Soviet Union had apparently agreed to a U.S. proposal to begin talks on banning hunter-killer satellites, which the USSR had been developing for about a decade. A senior Western diplomat said the Kremlin had formally conveyed its willingness to negotiate but had not said when. Marshal Nikolai V. Ogarkov, chief of staff of USSR armed forces, had outlined the Soviet position when he met with 21 visiting U.S. congressmen in Moscow. The Carter Administration had revealed earlier that it had suggested a treaty after 3 successful USSR tests of a new satellite (known in military jargon as Asat) able to maneuver close to another satellite in orbit and explode. If perfected, such a weapon (which the U.S. did not have) could threaten satellites used to verify compliance with strategic arms agreements, to give early warning of missile attack, or for civilian and military communications links.

The Pentagon was unhappy about the administration's decision to negotiate because it had 2 U.S. hunter-killer satellites under development: one could be launched into an orbit similar to that of the satellite to be destroyed, and another more maneuverable model using infrared sensors could seek out targets over great distances. The administration apparently hoped Pentagon plans would induce the Soviets to begin negotiations in Apr. It was not clear whether a treaty would cover only hunter-killer satellites or would include ground-based antisatellite weapons such as powerful laser beams, which the Pentagon opposed banning. (*NYT*, April 1/78, 5)

April 2: The National Academy of Engineering elected 100 engineers to membership in the academy, including astronaut Neil Armstrong, the *NYT* reported. Election honored persons contributing to engineering theory and practice or pioneering in new or developing fields of technology. (*NYT*, April 2/78, 35; *Bridge*, Spring 78, 2)

April 3: NASA announced it had adjudged performance of the *Heao 1* satellite successful, as it had accomplished its primary and secondary objectives. *Heao 1* had demonstrated that, in addition to its operating mode, normal scanning, it could point at specific celestial objects for detailed investigations; it had performed more than 50 pointings. NASA had solved some minor problems with the stored-command programmer early in the mission. The experiment complement had continued to receive high-resolution data over an energy range of 150 to 10 million electron volts. Although the sensitivity of the large-area counter array instruments had degraded, several of the counters remained unimpaired because of their modular construction and were able to achieve overall objectives.

Heao 1 data clarified x-ray sources barely visible in older studies; the faintest sources seen were 10 to the 5th times weaker than the first x-ray star (ScoX-1) discovered 15yr ago. *Heao 1* had identified many distant active sources, such as quasars, Seyfert galaxies, and BL Lacerta objects. For example, *Heao 1* observed the BL Lacerta object Markarian-5011 spectra, which were extremely hard, establishing the lack of surrounding gas. *Heao 1* had discovered that the strongest active sources in the galaxy were emitting radiation into the MeV range as a result of stimulation by strong nonthermal emission mechanisms. A map of diffuse x-rays in the range 0.15 to 60KeV indicated a hot thermal plasma extending beyond earth's galaxy, and possibly early evolution of the universe. (NASA MOR S-832-77-01 [postlaunch] April 3/78)

- The Mar. 25 launch failure of a Martin Marietta Titan 3C carrying 2 DOD/TRW defense satellite-communications system (Dscs 2) spacecraft had left the U.S. with degraded defense communications, *AvWk* reported. The situation could worsen if one of the aging spacecraft in synchronous orbit should fail before another Dscs 2 launch scheduled in about 6mo. One Dscs 2 spacecraft serving Atlantic Ocean traffic, another serving Western Pacific communications, and a third serving Indian Ocean traffic had normally handled worldwide superhigh-frequency defense-communications requirements for the U.S. A *NATO 3B* spacecraft had been on loan to provide communications in the Eastern Pacific. One of the lost spacecraft would have orbited over the Western Pacific, and the spacecraft already there would have replaced the *Dscs 2* nearing the end of its usefulness above the Indian Ocean. The other spacecraft located over the Eastern Pacific would have freed the *NATO 3B* spacecraft for return to its primary command. Loss of the 2 spacecraft meant that the oldest *Dscs 2* might fail before being replaced, leaving the Indian Ocean areas with less coverage and placing an increased burden on the Atlantic spacecraft.

Two Dscs 2 spacecraft had been intended for launch in 6mo as in-orbit spares; now they would become primary replacements for the pair lost Mar. 25. A normal Dscs 2 system would require 4 operational spacecraft and 2 in-orbit spares. In view of the recent failures and 2 previous ones, future Dscs launches and orbital operations would have to be 100% successful to maintain the system using all 16 spacecraft that NASA had procured. (*AvWk*, April 3/78, 19)

- A Saturn IB rocket, twin of the one that launched Skylab and

Apollo/Soyuz test project (ASTP) astronauts into space, would begin a barge journey from KSC to Tokyo Apr. 5, KSC announced. The Saturn IB, part of the largest group of U.S. space hardware ever displayed overseas, would be only one of hundreds of artifacts borrowed from NASA centers across the U.S. for a Japanese space science exposition scheduled to begin July 16, ninth anniversary of the launch of *Apollo 11*. The U.S. display would include full-scale Mercury-Redstone, Mercury-Atlas, and Gemini-Titan rockets; a lunar rover; Mercury, Gemini, and Apollo spacecraft that had actually flown in space; a detailed mockup of the Viking lander; and an ATS-6 (applications technology satellite) communications satellite.

The Association for the Space Science Exposition, an umbrella organization for the Japan Science Society and the Japanese Maritime Science Promotion Foundation, had organized the exposition at an estimated cost of $21 million and would defray all costs of dismantling, loading, round-trip shipping, reloading, and reinstalling artifacts. The National Air and Space Museum of the Smithsonian Institution had coordinated the loan of the space artifacts. (KSC Release 38-78; *Marshall Star,* April 19/78, 2)

April 4: The *W. Star* "In Focus" column reported that NASA had awarded a grant to Dr. T. Stephen Cheston, associate dean of Georgetown University's graduate school, to inventory the literature produced by the social sciences on space activities and to plan for a scholarly journal, an academic forum for lawyers, economists, historians, and other specialists on ways to handle the new technology. The column quoted Cheston as saying they would have a lot to think about: "What we need is wisdom and a hell of a lot of it," he said. He commented on the many social scientists working on problems related to what is called "the industrialization of space." By establishing a scholarly journal, he had hoped to raise the "general quality of discussions of these issues because so many people are working in isolation now."

The column noted that the Space Shuttle had made possible the launching of satellites that could intrude into many aspects of human endeavor; Capt. Robert F. Freitag, NASA's deputy director of advanced programs in space transportation, said that by 1984 the Shuttle should be ready to begin construction of the first large satellites, those with a diameter of at least 100ft. Although NASA was weighing a number of options, according to Freitag, the technology "is for all intents and purposes here today. It's just a matter of nations, large corporations, and institutions deciding to go ahead and do it."

Although some disciplines had generated little space-related literature, lawyers had been at work for a dozen yr producing 4 treaties governing outer space, with several more in the works. J. Henry Glazer, legal counsel at Ames Research Center, had said that some of the proposed treaties were "needed yesterday," because "technology has rapidly overtaken the legal questions involved." Glazer had predicted that large comsats of the late 1980s would be the forerunners of much larger economic enterprises in space, such as an orbiting power-generating station about the size of an ocean liner that could convert solar energy into electricity and beam it to earth in the form of microwaves; or the idea in a book written by Dr. Brian O'Leary, Princeton astronomer and physicist who had helped develop the solar-power satellite, on pushing a small asteroid into high orbit around the earth and mining it for space-station materials. When asked about the legal and social ramifications of such a concept, O'Leary admitted there were quite a few "gaps: The social scientists are hopefully going to play catch-up ball here." (*W Star,* April 4/78, A1)

• Launch of *Cosmos 1000*, reported FBIS, had led Soviet scientists to review highlights of the series. The research program using Cosmos satellites had used several types of unified apparatus, and the USSR had always referred to them as a "series" irrespective of their scientific missions. The virtually mass-produced output of satellites had greatly assisted the high turnover speed of the series, which had reached the 1000 mark within 16yr and 2wk, more than 500 launches having come in the past 6yr.

The Cosmos series had begun Mar. 16, 1962, with the launch of an unnamed satellite (named *Cosmos 1* only 3wk later, when Tass reported launch of *Cosmos 2*). The USSR had seldom announced the purpose of Cosmos launches, a ploy that permitted concealment of their purposes as well as of their failures. Observers had classified *Cosmos 96*, for instance, as a Venus probe left or stranded in orbit; *Cosmos 146,* which had arrived in orbit measuring about 14m long and by next day was only 9m long, after emitting 2 capsules, was probably a Soyuz precursor. Georgy Narimanov of the Soviet Academy of Sciences Institute of Space Research said the USSR had used Cosmos satellites to test long-range communications systems, reentry installations, life-support systems, and assemblies for the Lunokhod moon-rover, as well as automatic-docking procedures. Lack of information had encouraged speculation about military applications, including hunter-killer tests.

USSR comments had stressed the practical aspects of the Cosmos program, such as experience accumulated during geophysical experiments for use on the "Meteor" spacecraft; basic research by *Cosmos 321* that had defined distribution of the magnetic field over 94% of the earth's surface; and Cosmos investigations of the upper atmosphere, the aurora, and the magnetosphere. (FBIS, Tass in English, April 4/78; Tass Intl Svc in Russian, April 1/78 [2 items])

April 6: Mechanical failures during tests of the Space Shuttle main engines had threatened to delay the whole program, although the first orbital launch had been scheduled for next year, *AvWk* and *Nature* reported. Turbine blades in the engine's high-pressure fuel pump had failed in 3 separate tests: twice the blades fractured or cracked, the third time a fire that followed the malfunction destroyed the evidence. Dr. Robert Frosch, NASA administrator, said that the setbacks had not lessened agency confidence in the basic engine design and that the Space Shuttle program should proceed on schedule; however, he admitted that chances of launching the first manned orbital flight in Mar. 1979 were "considerably less than 50-50."

A committee from the Natl. Research Council had begun in Jan. to assess the nature of engine failures and related problems, and to advise NASA and the U.S. Senate subcommittee on science, technology, and space on the engine-development program, according to the NRC *News Report*. The study centered on the safety and reliability of the engines and had included evaluation of engine design, materials, fabrication, and testing. The Senate subcommittee had requested a report of the study in time to use it in considering NASA's authorization request for FY79. (*Nature*, Apr 6/78, 482; *AvWk*, Apr 3/78, 18; NRC *News Report*, Apr 78, 1)

• The People's Republic of China had announced an 8yr crash plan to catch up with the rest of the world in scientific research, *Nature* reported. Vice-Premier Fang Yi told 6000 delegates to the All-Nations Science Conference in Peking that China had lagged 15 to 20yr behind the West in many branches of science and still more in others; the program would narrow the gap in some areas to 10yr by 1985, and would help in overtaking the rest of the world in all branches of science by the end of the century. The article said that China had planned to begin production of fast-mainframe computers and to establish a strong computer network and data base by 1985, with extra attention to peripherals, software, and associated areas of applied mathematics. PRC would devote its efforts to basic space physics, cosmic rays, and technical problems of remote sensing, and planned to launch a series of Skylabs and deep-space and communications satellites within 8yr. (*Nature*, April 6/78, 482)

April 7: American Indians of the Far West had used the Communications Technology Satellite, world's most powerful, in an unusual undertaking: tribes in Mont. and N.M. had linked up via the satellite with each other and federal officials in Washington, D.C., to exchange information and views on health, agriculture, education, and other tribal concerns. ARC said the *Cts* experimental satellite, operating on a new frequency and at power levels 10 to 20 times higher than current commercial comsats, had provided 2-way interactive video and audio communications between ground sites, allowing participants to view and confer with each other as though in the same room. Lewis Research Center had developed the transmitter (its key component) and would manage U.S. portions of the joint U.S.-Canadian satellite program, the *Lewis News* reported. Indian nations taking part in the broadcasts over 3days were the Crows and other tribes from the northwestern U.S., and the All-Indian Pueblo Council, Inc., and nearby tribes from the southwest. Government representatives included the assistant secretary of the U.S. Dept. of Agriculture, senators, and representatives, the governor of Montana, and the assistant secretary for Indian affairs in the U.S. Dept. of Interior. (ARC *Astrogram,* Apr 7/78, 2; *Lewis News,* Apr 14/78, 1)

- The Air Force had launched at 7:45pm the previous Thursday a secret payload aboard an Atlas-Agena rocket from Cape Canaveral, *Today* reported. The launch, not previously announced, resembled previous unannounced launches that had carried various spy satellites. The launch followed 3 consecutive unsuccessful military missions. In Feb., an experimental Trident fleet ballistic missile had failed after launch from a land pad at the Air Force station; in Mar., DOD officials had destroyed both a Titan III-C rocket carrying 2 Triple 7 defense communications satellites and a Poseidon fleet ballistic missile. (*Today*, April 7/78, 1A)

- NASA had not yet decided when to command the Skylab space station into a cartwheel maneuver that could extend its orbital life by 9 to 14mo, *Science* magazine reported. The maneuver could increase chances of a Space Shuttle mission either boosting Skylab or propelling it into controlled reentry. Major factor in the decision would be assessment of how long the station's control-moment gyros could sustain the maneuver before failing; without the cartwheel, NASA believed reentry would occur between May 1979 and July 1980. According to *Science,* however, Skylab's chances of remaining in the sky until NASA could get to it with a Space Shuttle were no better than 1 in 2. (*Science,* Apr 7/78, 28; *AvWk*, Apr 24/78, 15)

- The National Aeronautic Association announced the 1977 Collier trophy winners: U.S. Air Force Gen. Robert J. Dixon, and the Tactical Air Command headed by him since 1973. The NAA had awarded the Collier trophy annually for U.S. achievement in aeronautics and astronautics during the preceding yr; the selection committee had made the award for development and implementation in 1977 of the Red Flag combat-simulation flight-training program.

Red Flag, designed to enhance combat readiness of U.S. air crews, had been regarded as a significant contribution to national defense. Encounters in Red Flag, consisting of missions against simulated surface-to-air missiles, had been the most realistic undertaken in peacetime aerial-combat training. Gen. Dixon had established the program in 1977, conducting ten 4-wk exercises at Nellis Air Force Base, Nev.; more than 8200 air crews had trained during 1977, with 10 000 ground troops participating. (NAA newsletter Apr 7/78)

- The plane flown by Amelia Earhart when she disappeared would be the target of a search party headed by Vincent Loomis departing soon for the Marshall Islands, the *W Star* reported. Loomis, a USAF officer who had conducted aerial surveys to set air-navigation markers in advance of the H-bomb tests at Bikini atoll, said he had spotted plane wreckage but was in a hurry to finish his job. Some yrs later he had read a magazine article on the search for Earhart, and remembered the wreckage. Loomis said a simple navigational error could have put the Earhart plane over the Marshalls, north of her destination at Howland Island. Fred Goerner, who had combed the Pacific for clues to Earhart's fate, called the venture "a very, very, very long shot," especially since the area "has been surveyed and surveyed and every one of the islands has been visited and visited in recent years"; he said it was unlikely that evidence would have remained undiscovered. (*W Star,* April 7/78, C6)

- Flight testing of the Space Shuttle's microwave scanning-beam landing system (MSBLS) had begun at KSC, *Today* reported, with pilots and technicians using a specially equipped Jetstar aircraft operated by Dryden Flight Research Center to conduct the tests. The system-verification tests would be the initial checkout of the airborne MSBLS/Jetstar system and the ground stations with their laser systems to verify compatibility, and to check out the system processing test data. KSC had scheduled 5 test flights lasting a total of about 12hr. (*Today*, Apr 7/78, 12A; DFRC *X-Press,* Apr 7/78, 2)

April 10: NASA announced plans to launch orbital test satellite OTS-B, forerunner of an operational system, for ESA from Cape Canaveral no earlier than Apr. 27. This new comsat was 1 of 2 experimental models built by ESA to test satellite performance in orbit, with its operational descendants expected to provide satellite links in the 1980s for routing portions of intra-European telephone, telegraph, and telex traffic and providing TV relay services for Western Europe. Under an agreement between the U.S. and ESA, ESA would reimburse NASA for Delta launch vehicle, launch services, and other administrative costs totaling $17 million. NASA had launched *Ots 1* Sept. 13, 1977, on a Delta rocket from Cape Canaveral; the Delta first stage exploded 55sec. after liftoff. A burn-through of one of the solid-propellant strap-on Castor IV motors, subsequently modified, had caused the explosion. (NASA Release 78-53)

- KSC announced award to the International Hydrodynamics Co., Vancouver, British Columbia, of a contract for systems to recover expended Space Shuttle solid-fuel rocket-booster (SRB) casings. The $1 million contract would cover fabrication, testing, and delivery of the recovery systems with associated equipment and hardware. Recovery of SRB casings would mean sizeable savings to the Shuttle program; estimating 19 reuses of a casing, the savings realized by reuse (including cost of retrieval and refurbishment) would be $47 million. (KSC Release 37-78)

April 11: NASA announced that the solar-wind detector aboard Saturn-bound *Pioneer 11* had begun operating again, after lying dormant for 3yr despite scientists' repeated efforts to revive it. The solar-wind detector would apparently be ready for the 1979 encounter with Saturn for closeup pictures and other first-time measurements. Experimenters who completed an exhaustive checkout of the instrument were confident it was working properly. The solar-plasma analyzer, designed to map the flow of the million-mph wind continuously flowing out of the sun across the solar system, should provide important information about the interaction of solar-wind particles with Saturn and its rings. Investigators would compare these data with data gathered by the instrument 3yr ago when *Pioneer 11* swung around Jupiter.

The instrument had ceased operation shortly after the Jupiter encounter; in October 1977, after exhaustive analyses and a number of commands to the instrument (none of which worked), investigators decided to turn on the instrument's high-voltage power source to "thermally shock" the output circuits into operation. This had apparently worked, as 36days later NASA tracking stations reported the first transmission of data in nearly 3yr. Since then the instrument had responded to all radio commands, and appeared to be in condition for the Saturn encounter. (NASA Release 78-58)

April 12: Marshall Space Flight Center announced that the Bethpage, N.Y., plant of Grumman Aerospace Corp. had almost completed fabrication of an automatic device for forming continuous structural beams in space. MSFC had developed the "beam builder" to demonstrate techniques for fabricating large structures in space; the device would form triangular beams from flat rolls of very light materials, a complete section of the beam being easily supported with one hand. Housed in the cargo bay of the Space Shuttle in earth orbit, the machine would form continuous miles-long beams for building large structures such as satellite power systems and service platforms. (*Marshall Star*, Apr 12/78, 1)

- ESA announced that since the end of March its *Meteosat 1* had been transmitting daily meteorological data collected by special equipment aboard a French naval vessel in the North Atlantic. ESA had relayed the data to the European Space Operations Centre (ESOC) in West Germany. The satellite had transmitted messages every 3hr that included the ship's position, and parameters such as wind characteristics, sea states, and air and sea temperatures. The experiment, carried out jointly by the French meteorological service and ESA, had been planned to demonstrate the reliability of automatic communications between ships and the *Meteosat 1* satellite for regular production of meteorological reports. The experiment would last until July and would resume later with other European meteorological services. When operational, the system should include several hundred ships all over the world fitted with Meteosat equipment. (ESA Release, Apr 12/78)

- FBIS reported the answer of Konstantin Petrovich Feoktistov, USSR pilot-cosmonaut, when queried on the future of orbital stations. Feoktistov said they would develop as multipurpose scientific laboratories for extra-atmospheric astronomical observations, and for technological experiments to produce materials unobtainable under earth conditions. Orbital stations could seek out the most effective systems to develop methods for research and development and the design of scientific instruments and equipment. He went on to say: "Very broad prospects are opened up for manned stations if they are examined above all as the basis for industrial construction in space. Not everyone shares this view, but I personally believe that within the next few decades the development of technology will make it possible to actually set the task of creating power plants in space."

Feoktistov noted that such technology would mean putting millions of tons of diverse equipment into space to assemble enormous and complex structures. Such work could never be fully automated, he pointed out, and would require many people to control the equipment and carry out installation work. This would not happen quickly, he concluded, but it should not be relegated to the realm of fantasy. "After all, 17yr ago Yuri Gagarin's flight also seemed a fantastic achievement." (FBIS, Moscow Sotsialisticheskaya Industriya in Russian, Apr 12/78)

April 13: Langley Research Center announced it had awarded SDC Integrated Services, Inc., McLean, Va., a contract for support services to operate the digital-computer complex at the center. All segments of the center would use the computer complex in analytical studies, real-time simulations, and experimental data reductions. Services under the contract would include operation of the computing and data-handling equipment, operational and performance analysis, and keypunch and auxiliary equipment operation, in addition to research-data reduction such as programming, processing preparation, and data management. SDC had estimated the cost of the 2-yr base period of the contract at $5.7 million and a 1-yr option at $3 million; the cost-plus-award-fee contract also had two 1-yr unpriced options. (LaRC Release 78-17)

• Wallops Flight Center announced the first flight Apr. 10 in compound-helicopter configuration of its rotor-systems research aircraft (RSRA), a new research helicopter equipped with rotors, wings, and 2 jet engines. The compound configuration included the addition of 2 auxiliary-thrust engines and a 13.7m (45ft) wing. Powered by its 2 TF34 turbofan engines, the RSRA had used the combined lift of its wing and 5-blade S-61 rotor system to achieve an altitude of 610m (2000ft). By testing rotor systems to maneuver the craft at a wide range of altitudes and air speeds not possible in wind tunnels, RSRA would improve assessment of rotor performance by distinguishing inflight rotor characteristics from aircraft-system characteristics, which could not be done on the ground or in other aircraft. When fitted with fixed wings, the RSRA could test unproven rotor systems too small to lift it in normal flights.

Sikorsky Aircraft had built 2 RSRA vehicles under a program, jointly funded and managed by NASA and the U.S. Army, to develop technology to increase rotor-aircraft speed, performance, reliability, and safety, and to reduce helicopter noise, vibration, and maintenance. Sikorsky, under contract to LaRC, would test both RSRA vehicles for approximately 80hr flight time before delivering them to NASA and the Army for flight research at NASA's ARC. Sam White, NASA RSRA project manager, said, "The RSRA will help eliminate the costly practice of having to develop or extensively modify helicopter aircraft in order to conduct flight investigations for each promising new rotor concept. The RSRA is readily adaptable to accommodate new rotors and provide precise measurements of a variety of rotors under repeatable test conditions." (NASA Release 78-59; LaRC Release 78-16)

April 14: NASA announced successful launch of a FltSatCom-A Feb. 9 on an Atlas-Centaur from ETR's launch complex 36 at 1617:01hr EDT. Transfer-orbit parameters were 35 968.5km apogee, 167.20km perigee, and 26.4° inclination. NASA had fired the apogee-kick motor on Feb. 11 to inject the spacecraft into the desired synchronous orbit. All spacecraft systems were operating normally. (MOR M-491-202-78-01 [postlaunch] Apr 14/78)

• NASA announced that the Jupiter-bound *Voyager 2* was having problems with both its radio receivers that prevented Jet Propulsion Laboratory engineers from sending commands to the spacecraft. Early spacecraft data had indicated failure of one receiver, and the backup receiver might have had trouble receiving commands from earth; the spacecraft had continued sending information to earth. The Voyager had been designed to switch radio receivers if it had not received earth command for 7 days; the receiver that appeared to have failed had been the one on-line, and in 7 days the spacecraft computer should automatically switch to the backup receiver. Engineers would then attempt to reestablish communications by sending commands to the spacecraft. (NASA Release 78-56)

The *Voyager 2* spacecraft had accepted a command, the *W Star* reported, ending a week-long radio failure that had threatened its mission to Jupiter and Saturn. To protect the mission, engineers at JPL had begun reprogramming the spacecraft's onboard computer "so it will still do its science when it passes Jupiter and send back the results whether we can talk to it or not," said JPL spokesman Frank Bristow. Earlier in Apr., the spacecraft had automatically switched from the primary to secondary receiver because Voyager had not received an uplink from tracking stations for 7 days; the commands had not been sent because controllers had been preoccupied with scan-platform problems on *Voyager 1*. Controllers were reviewing their activities to pinpoint why they had overlooked an uplink, to ensure the lapse would not recur during the mission. (*W Star*, Apr 14/78, A-7; *AvWk*, Apr 17/78, 20)

- Scientists at JPL had assisted UCLA doctors in treating tumors with heat therapy, or hyperthermia, JPL *Universe* reported. While other researchers were exploring various ways of treating cancer with heat, UCLA neurosurgeon Robert Rand and veterinary radiologist Harold Snow had developed the concept of using a magnetic field to focus intense heat on specific diseased organs without damaging surrounding tissue or other parts of the body; To get the complex equipment required to test the theory, the doctors had enlisted the help of JPL scientists Dr. David Elliott and Glenn Haskins.

Dr. Rand had reasoned that, if heat would aid destruction of cancer cells, applying heat to an organ injected with magnetic material might more effectively deaden the tumor and any peripheral cancer cells. He asked Elliott and Haskins to design a magnetic heating system and build the equipment to see whether isolated organs could be heated. The JPL scientists had created a field coil to surround a patient's body, generating a 0.1tesla (1,000gauss) magnetic field at a frequency of 5000Hz to heat a magnetized organ to temperatures up to 55C for approximately 5min. Initial tests on rabbits had elevated the temperature of an isolated organ as anticipated; further testing on dogs would determine if the method worked on larger subjects. (*JPL Universe*, Apr 14/78, 2)

- The NASA 928 aircraft, Johnson Space Center's high-altitude WB-57F operated by its Aircraft Operations Division for DOE, had made 2 flights for the National Center for Atmospheric Research (NCAR), *JSC*

Roundup reported, to support research on the transfer of pollutants from the troposphere to the stratosphere in the vicinity of jet streams. The plane had taken air samples at altitudes between 35 000 and 60 000ft and measured the samples with onboard sensors: the stratospheric Aitken-nuclei detector, and the ozone monitor. The former would determine concentration and size of Aitken nuclei, considered tracers for tropospheric air, and the ozone monitor would determine the concentration of ozone, a tracer of stratospheric air; Nuclei-detector data superimposed on ozone-monitor data would define pollutant transfer. NCAR would analyze the data and reimburse JSC for the cost of the flights.

NASA-928 aircraft, equipped with various sensors, were used primarily to determine concentrations of radioactive particulates and gases and other trace constituents at several altitudes in the upper atmosphere (40 000 to 65 000ft). (*JSC Roundup,* Apr 14/78, 1)

- JPL's Edward Divita would be featured speaker at a meeting on nuclear waste disposal in Los Angeles Apr. 18, sponsored by the Institute of Electrical and Electronics Engineers, Nuclear and Plasma Sciences Society. Divita, a professional nuclear engineer who had performed several radiation studies of nuclear and space systems, analyzing and assessing the various disposal options, would speak on "Technical Status of Salt Bed, Sea Bed, and Space Waste Disposal." (*JPL Universe,* Apr 14/78, 1)

April 17: NASA announced it had accepted the review board's final report on failure of the Delta launch vehicle carrying ESA's orbital test satellite OTS-A that exploded after liftoff from Cape Canaveral Sept. 13, 1977. The review board had concluded that the failure resulted from a defect in the propellant of the solid-fuel strap-on Castor IV motor No. 1: either incomplete mixing and curing of propellant ingredients, or introduction of a contaminant, most likely water.

The board's findings had led to changing the design of the Castor IV solid-fuel rocket motor by putting additional insulation between the propellant and motor case to protect against such defects. NASA had also revised procedures for mixing and curing the propellant, and had improved the contractor and government test, inspection, and manufacturing surveillance procedures. New Castor IV motors incorporating the corrective actions had been manufactured and requalified. A second orbital test satellite, OTS-B, to replace OTS-A had been scheduled for launch May 4 from Cape Canaveral. (NASA Release 78-61)

- NASA had been considering FY81 and 82 missions to send a probe toward Halley's comet and land it on Tempel 2 comet, and one that would return a sample of Martian soil to earth, *AvWk* reported. Return of a Mars sample—to be studied first aboard the Space Shuttle in earth orbit—had become the key mission sought by scientists planning Mars strategy for NASA, who viewed a sample mission as a direct follow-on to the Viking mission in progress. NASA would have to make its decisions this summer on specific missions for FY82.

NASA might request the comet mission for FY81, in view of the determination by NASA planners and scientists to send a spacecraft near Halley's comet, even though a plan to rendezvous with the comet had disappeared when NASA was unable to obtain a Halley mission in FY79. The Halley/Tempel 2 comet mission would consist of a 1985 Space Shuttle launch of a vehicle using solar-electric propulsion to encounter Halley's comet in Nov. 1985 about 93 million mi from earth, eject a probe that would dive into the head or nucleus area of the comet, and return atmospheric data. The mother spacecraft would continue a high-speed flyby of the comet, either passing through the comet's tail or flying a safer trajectory in front of it. (*AvWk*, Apr 17/78, 14)

• NASA had under consideration for FY83 a supersonic-technology demonstrator, *AvWk* reported: an arrow-wing design in the 75 000-lb class suggested by a Boeing concept, although the company was not pursuing development of the vehicle. Boeing had proposed building such an aircraft to obtain cost information and to validate aerodynamics and manufacturing concepts for other U.S. aircraft manufacturers thinking of building operational supersonic transports. If NASA decided to pursue the project with DOD, agencies would probably seek participation by Lockheed, McDonnell Douglas, and Boeing. (*AvWk*, Apr 17/78, 31)

• NASA had cancelled the Lockheed/JPL SeaSat ocean-research spacecraft launch planned for May 17, *AvWk* reported, because of a failure in its synthetic-aperture radar downlink transmitter. Lockheed had detected the failure during thermal-vacuum testing of the spacecraft. Launch would be postponed until early June; the postponement would delay launch of the RCA/Goddard Tiros-N weather satellite to early Aug., because both missions would go on General Dynamics's Altas boosters that must use the same pad at Vandenberg AFB. Analysis of the SeaSat failure had revealed damage to a ceramic circuit board during manufacture; all other SeaSat systems functioned normally in the test. (*AvWk*, Apr 17/78, 27)

• *AvWk* reported that the Soviet Union had labeled the U.S. Space Shuttle a killer-satellite development, and U.S. officials planning talks with the USSR had been debating how to refer to the Space Shuttle in these discussions. NASA had been concerned about the effect on the Space Shuttle program of antisatellite negotiations, although U.S. negotiators had stated they had no intention of trading away Space Shuttle capability for USSR concessions. Informal negotiations on limitation of antisatellite-weapons tests had been set for May; U.S. officials said that NASA must have expected the Space Shuttle to be part of antisatellite discussions. As the Soviets had not cited the Space Shuttle by name, but rather as a "manned system of dual use," U.S. officials had not decided whether the concessions sought by the USSR would be on overall Shuttle capability, on individual Shuttle capabilities, or on individual potentially antisatellite Shuttle missions. (*AvWk*, Apr 17/78, 17)

April 18: NASA announced award of a $5 million contract to Vought Corporation, Dallas, Tex., for 5 Scout launch vehicles and associated hardware, such as separation systems and heat shields. Vought had been the Scout project's prime contractor since 1959. The first Scout, designed to place a 130-lb payload into a 300-nautical-mi circular earth orbit, had been launched in 1960. The new Scout could launch a 404lb payload from Wallops Island, Va.; Vandenberg Air Force Base, Calif.; or San Marco offshore at Kenya, Africa, into that orbit. The latest configuration of Scout vehicles was known as Phase 8; phases 1 through 7 had produced 107 vehicles, 96 of which had been launched. (NASA Release 78-20)

April 19: NASA announced plans to conduct the first full design-limit test of the parachute-recovery system for Space Shuttle solid-fuel rocket boosters. A B-52 aircraft flying at an altitude of 21 000ft would drop a 48 000lb dummy booster over the National Parachute Test Range at El Centro, Calif. Three main parachutes plus the pilot and drogue parachutes would deploy to slow the rate of descent. Primary objective of the test would be to simulate at a high dynamic pressure the loads that the main cluster of parachutes would encounter in actual use. MSFC would be responsible for the solid-fuel rocket boosters; Martin Marietta Corp. had been under contract to develop the recovery system; and DFRC would be responsible for B-52 operations. (*Marshall Star,* Apr 19/78, 3; DFRC Release 10-78)

- The USAF's Space and Missile Systems Organization (SAMSO) announced award of a contract to Boeing Aerospace Company, Seattle, Wash., for full-scale development and initial production of an inertial upper-stage (IUS) vehicle system, consisting of a 3-axis-stabilized vehicle of multiple solid-propellant stages with an avionics section including a reaction-control system. Although the USAF had primary responsibility for development of the IUS, NASA would participate in development because it also would use the IUS. The basic concept, a 2-stage vehicle for use with the Space Shuttle and on the Titan for some USAF missions, had one 20 000lb solid-propellant motor and one 6000lb solid-propellant motor that would deliver a 5000lb spacecraft to geosynchronous orbit.

NASA also planned two other vehicle configurations, one to carry large spacecraft on planetary missions and another for deep-space missions such as Galileo, a probe of the planet Jupiter. The Space Shuttle would deliver all NASA IUS vehicles to low earth orbit for use in pushing spacecraft to higher orbits or to earth-escape trajectories. The first NASA IUS flight would be a mission planned for summer 1980 to launch a tracking and data-relay satellite (TDRS); first use of a 3-stage IUS would be the Galileo mission planned for launch Jan. 1982. (*Marshall Star,* Apr 19/78, 1)

April 20: NASA announced that Dr. Eugene Emme, NASA historian since 1959 and developer of the NASA history program of professional and general publications recording the agency's development, would retire May 1 to devote full time to lectures and writing on aerospace science and technology history. Prof. Thomas Hughes, chairman of the NASA History Advisory Committee, said that Emme was "not only present at the creation of what is virtually a new discipline – space history – but he also played a central role in establishing sound institutional support for that discipline."

Emme had been founding chairman of the history committee of the Natl. Rocket Club (later the Natl. Space Club) and had served on the history committees of the American Inst. of Aeronautics and Astronautics and the American Astronautical Society. He had been a corresponding member of the Intl. Academy of Astronautics, a fellow of the American Association for Advancement of Science, the British Interplanetary Society, and the AAS; and he was an associate fellow of AIAA. (NASA Release 78-63)

April 21: NASA announced it had invited scientists to submit proposals for life sciences experiments to be carried aboard the Space Shuttle and Spacelab in the early 1980s. The experiments would study physical effects of spaceflight on humans and other living systems, and would test equipment and procedures. These experiments would be performed in the pressurized cabin of the Space Shuttle orbiter, in a pressurized Spacelab module, or (if requiring continuous exposure to the space environment) attached to an unpressurized Spacelab pallet. Proposed investigations would have to meet one or more of the following life sciences objectives: investigate and understand physiological, performance, and biochemical changes observed in humans who had flown in space; identify and investigate significant biological phenomena that might occur during or after exposure to the space environment; and/or test and demonstrate under operational conditions the equipment and procedures that would be needed by the NASA life sciences program. (NASA Release 78-64)

• DFRC announced it had tested on one of the center's YF-12 aircraft a dual-mode landing-gear system that used variable stiffness landing gear to reduce structural fatigue and dampen vibrations for future large aircraft ground operations. Three different landing-gear configurations tested at various speeds and weights over rough portions of the runways and taxiways resulted from changing loads on both the main and nose landing gear. (*DFRC X-Press*, Apr 21/78, 2)

April 24: AvWk reported that the Senate Commerce subcommittee on science and space had become the second congressional group to add another $4 million for a fifth Space Shuttle orbiter to NASA's FY79 budget, challenging President Carter's decision to defer purchase. This equalled the amount provided earlier by the House Science and Technology Committee. Overall, the Senate subcommittee had increased NASA's $4.371-billion budget request by $13 million, but failed to agree with some earlier House changes that had given NASA a $15.5-million increase. Among Senate subcommittee changes were $3 million for advanced manned-spaceflight programs, $4 million less than the House; language added to stress the importance of continuing lunar exploration; $2 million of $4 million deleted by OMB, restored for Spacelab experiments; and $3 million added for large space-structures work, making a total of $111.3 million for this item. (*AvWk* Apr 24/78, 27)

• The International Civil Aviation Organization's All Weather Operations Div. announced it had selected the U.S./Australian scanning-beam microwave-landing system at its meeting in Montreal, following West Germany's withdrawal of its MLS system from the competition. The final 39 to 24 vote (with 8 abstentions) had been secret to ensure that delegates could freely express their preferences.

France had proposed the secret ballot, strongly supported by the United Kingdom, Ireland, and Sweden, all of whom favored the Doppler MLS, as well as others. Asked whether the U.K. planned to continue the battle in ICAO's Air Navigation Commission, which must act on the decision rendered in Montreal, a representative said the U.K. had accepted the decision of delegates from 71 countries.

The meeting had been remarkably free of charges of improper efforts to win delegate votes. Asked if they had been subjected to any political arm-twisting or offers of political plums, delegates from Third World countries acknowledged that they had "intensive technical briefings" but nothing more. In view of the secret ballot, an observer commented that "if any quid pro quos were offered during this bitter battle, the offerer has no way of knowing now whether he got full value in return." (*AvWk* Apr 24/78, 23)

- The ESA Council had given the go-ahead to produce an initial batch of 5 operational Ariane launch vehicles, and had approved interim funding of approximately $23.8 million for preliminary production-related expenses, *AvWk* reported. Although individual participating countries must approve the expenditures, Council approval had been sufficient to begin production. The first operational launcher should be available by the end of 1980 to launch ESA's Exosat scientific satellite in early 1981. Cost of the 5-launcher package had been estimated at approximately $182.6 million, with an additional 10% proposed as a contingency reserve. Total budget would amount to about $200 million. At West Germany's insistence, the individual satellite programs that would use the Arianes would fund the launcher costs.

Program managers at ESA had sought approval to produce a first batch of 6 Arianes; however, policy of governments involved was to fund production of launchers only for identified markets. Once production buildup was completed, production rate of the Ariane was expected to reach 2 vehicles per year; program officials predicted this could increase rather quickly to 4, or possibly 5, a year to meet market demand. (*AvWk* Apr 24/78, 96)

April 25: NASA announced plans to launch an orbital test satellite (OTS) May 4 on a Delta rocket from Cape Canaveral; KSC would launch the experimental comsat for ESA. (KSC Release 45-78)

- The House of Representatives, in a Committee of the Whole House, by a vote of 345 to 54 passed H.R. 11404, authorizing appropriations to NASA for research and development, construction of facilities, research and program management, and other purposes. Alterations in the bill resulted in a net increase of $43.7 million to the budget NASA had submitted. Included were a $4-million increase to maintain the option for a fifth Space Shuttle orbiter; a $5-million decrease for expendable launch vehicles, slated to be phased out; a $3-million increase for space structures, power conversion, and microwave technology; a $3-million increase in energy-technology applications for solar-satellite power; a $10-million increase for applications research and technology development; a $1.5-million increase for industrial applications; a $4-million increase for technology applications (bioengineering); a $4-million increase for Spacelab systems implementation; and a $4-million increase for a Stereosat development program.

In debate recorded in the *Congressional Record*, Rep. Olin Teague (D-Tex.) of the House Committee on Science and Technology noted that

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NASA had scheduled 25 launches in 1978, 11 on Delta (launch vehicles) and 8 on Atlas Centaurs, with NASA personnel supporting 3 Atlas-F launches from Vandenberg Air Force Base: "Most of the launches in 1977 emphasized the use of space for the direct benefit of people on earth—such as communications, geodetic, environmental, navigation, meteorological, and earth resources. In 1978 plans call for missions virtually equally divided between emphasis on these applications and launches of spacecraft for primarily scientific and exploratory research.

"Fifteen launches will be for paying customers other than NASA. They include the European Space Agency, ComSatCorp., the U.S. Navy, Japan, the National Oceanic and Atmospheric Administration, the United Kingdom, and Canada.

"The launch schedule for 1978 could not have been conceived of in 1958 when our space program began. In 1998 people will look back to 1978 and likely say the same thing. That will only occur if we support a strong continuing space program." (*CR*, Apr 25/78, 3164-3166)

April 26: The *Marshall Star* reported that 6 American and 2 British scientists would compete for the 2 experimenter seats on the second flight of the Shuttle-borne Spacelab experiments in 1981. The experimenters, called payload specialists, would be employed by the payload sponsor and would differ from NASA's pilots and mission specialists in being selected and trained for a specific mission. Four selected from the group of 8 would train to operate the mission's 13 scientific investigations; NASA would choose 2 of the 4 to fly on the 7- to 12-day mission.

The investigators working group (IWG), scientists representing 13 experiment teams for the U.S. and the United Kingdom charged by NASA with directing Spacelab scientific investigations, had selected the candidates for payload specialist. MSFC would manage the training programs for all 4 payload specialists. The Spacelab 2 finalists would be the second group of candidates for flight assignments; 10 Spacelab 1 payload-specialist finalists had been selected in Dec. 1977 to compete for 2 flight positions.

Finalists for the Spacelab 2 payload-specialist positions were Loren Acton, Lockheed's Palo Alto research laboratory; John-David Bartoe, Naval Research Laboratory; John Harvey, Kitt Peak National Observatory; Bruce Patchett, Astrophysics Research Division of Appleton Laboratory; N. Paul Patterson, Ball Brothers Research Corporation; Dianne Prinz, NRL; George Simon, Sacramento Peak Observatory; and Keith Strong, Mullard Space Science Laboratory. (*Marshall Star*, Apr 26/78, 4)

• MSFC announced it had completed acoustic testing of NASA's second high-energy astronomy observatory HEAO-B, first in a series of environmental tests on the satellite before its launch scheduled for Nov. HEAO's prime contractor, TRW Systems, Inc., Redondo Beach, Calif., performed the test that simulated sound pressure generated during launch. HEAO-B, second of 3 large unmanned orbital observatories designed to study x-rays, gamma rays, and cosmic rays emitted by stars and star-like objects throughout the universe, had been moved into TRW's thermal-vacuum chamber for further testing in June. (*Marshall Star*, Apr 26/78, 2)

- MSFC announced it had established a project office to develop an atmospheric cloud physics laboratory (ACPL) as a cargo for Spacelab in the early 1980s, so that scientists could for the first time study cloud physics without gravitational disturbances. Comparisons between earth-based observations had frequently not correlated with occurrences in actual clouds. The ACPL facility would permit observation of the processes of freezing, thawing, collision, electric charging, and temperature changes, photographing them as frequently and for as long as necessary. NASA had planned to send up the first ACPL mission on Spacelab 3, tentatively scheduled for June 1981. (*Marshall Star*, Apr 26/78, 3)

April 27: NASA announced successful launch Apr. 26 from Vandenberg AFB on a Scout of the first spacecraft built to measure variations in the earth's temperature, the heat-capacity mapping mission (HCMM). The experimental satellite had assumed a circular sun-synchronous 620km (385mi) orbit to measure areas of the earth's surface for maximum temperatures, then to measure minimum temperatures of those same areas about 11hr later. A 2-channel scanning radiometer would acquire images in the visible and near-infrared spectrum during the day, and in the thermal-infrared spectrum both day and night. Data resolution of the 2 channels would be about 0.5 × 0.5km (1800ft) as the spacecraft covered a 700km (435mi)-wide swath. Project officials said the position of the 300lb satellite in orbit was "almost perfect. If all goes well, we could take a picture of the earth in the visible spectrum as early as tomorrow."

HCMM was first in a series of low-cost modular spacecraft built for the Applications Explorer Missions (AEM)—small, experimental spacecraft in special orbits to satisfy mission-unique experimental data-acquisition requirements. Scientists designed the mission to determine the feasibility of using day-night thermal-infrared remote sensor-derived data to detect various rock types and mineral resources; monitor surface soil-moisture changes; measure plant-canopy temperatures at frequent intervals to detect transpiration of water and plant stress; measure urban heat islands; map surface-temperature changes on land and water bodies; and analyze snow fields to predict water runoff. HCMM data, correlated with data from other satellites (especially Landsat) and from ground observations, could aid in detecting time variations of temperatures on the earth's surface. Goddard Space Flight Center had been responsible for design, integration, and testing of the satellite and for data processing. Boeing Aerospace Co. had built the base module, International Telephone and Telegraph the instrument. (NASA Release 78-60; MOR E-651-78-01 [prelaunch] Apr 19/78; *NYT*, Apr 27/78)

April 28: JPL reported it would participate in tracking and data acquisition as well as in navigation during the upcoming Pioneer Venus mission. Hughes Aircraft Co.'s Space and Communications Group had designed 2 spacecraft and 4 probe vessels for the mission, and General Electric Co.'s Systems Division would provide a probe-entry system. R. B. Miller would be tracking and data systems manager at JPL, with William Kirhofer responsible for the navigation phase.

First would be an orbiter carried in the nose cone of an Atlas-Centaur scheduled to go aloft from KSC May 20; the multiprobe vessel would be launched Aug. 7, also on an Atlas-Centaur. The flight to Venus would be relatively short, about 6mo for the orbiter and about 5mo for the multiprobe. The orbiter would study the atmosphere and other characteristics of Venus for 243 days.

In the multiprobe phase a large entry probe would make a detailed sounding of the lower atmosphere and clouds of Venus, and 3 smaller probes would measure widely separated areas of the planet's atmosphere. To conserve energy, JPL trackers and navigators would turn on the battery-powered radio transmitters of the probes only about 20min before entry into the atmosphere; ground controllers would not be able to check frequencies between launch in Aug. and shortly before entry in Dec. The orbiter-and-multiprobe mission would carry about 30 instruments for gathering scientific data on Venus. (JPL *Universe*, Apr 28/78, 1)

- NASA had completed an ignition test Apr. 21 on 3 Space Shuttle main engines at the National Space and Technology Laboratory at Bay St. Louis, Miss., the JPL and KSC newsletters reported. The firing planned for 2.5sec had actually lasted only 1sec, but NASA officials said the test had met most of the objectives. A low-temperature reading in the fuel-pressure pumps caused premature cutoff. NASA and Rockwell Intl. engineers would decide whether to repeat the test before moving to the next phase of the program. (*JSC Roundup*, Apr 28/78, 1; *Marshall Star*, Apr 26/78, 2)

During April: NASA reported it had increased emphasis on general-aviation research, addressing problems and concerns of the industry, which had used results from recent programs in designing new aircraft. Objectives of NASA's general-aviation research had been to improve safety and efficiency, reduce environmental impact of general-aviation aircraft, and ensure a base of new technology adequate to support continued growth in the light-airplane utility. Aerodynamic research had emphasized airfoil development, resulting in significant improvements in performance in all speed ranges. Avionics research had aimed at reducing the complexity and cost of aircraft interaction with traffic-control systems improving navigation, guidance, stabilization, and systems management.

In generating information needed to design low-cost advanced avionics systems applicable to general aviation in the 1980s and beyond, NASA had integrated results of its studies into specifications for final systems design, fabrication, and installation on a twin-engine general-aviation aircraft for flight evaluation in 1979 and 1980. NASA had also defined technical problems that had limited accuracy and efficiency in aerial application of agricultural materials. The NASA program also had emphasized safety measures, including an automatic pilot-advisory system (APSA), structural crashworthiness, stall/spin research, and investigation of alternative fuels such as automotive gasoline for aircraft. Reducing the environmental impact of noise and exhaust emissions generated by light aircraft had also been an objective of NASA's aeronautical program, which would eventually assist industry and regulatory agencies in meeting future noise and pollution-reduction goals. (NASA Release 78-41)

• NASA announced that the Delta vehicle scheduled to launch the Japanese broadcasting satellite for experimental purposes (BSE) from KSC Apr. 7 had been qualified for flight, following an investigation and tests resulting from detection of a leak in the first stage of the Delta used in the successful launch of NASA's *Landsat 3* from Vandenberg AFB Mar. 5. The pogo accumulator that suppressed pogo-stick-like vibration in the fuel system during flight had been the most probable cause of the leak. NASA had installed a new pogo accumulator, previously subjected to screening and test, in the Delta for BSE launch. (NASA Release 78-55)

• NASA's role in basic and applied research under its charter—the Space Act of 1958—had created a paradox, NASA Administrator Dr. Robert Frosch said in a speech to GSFC employees, the *Goddard News* reported. NASA had been in the business of producing change, but the really interesting changes had not been predictable from past experience. "The interesting things happen because somebody not only changes the idea of how to solve the problem but questions the basic problem," Frosch said. "Thus the R&D problem faced by the applications part of our agency is that of trying to do work that not only satisfies the perceived mission questions, but will change the nature of the mission, or change the nature of the problem." Current NASA assignments included defining its R&D

posture, deciding the proper balance of basic and applied research, selecting what problems to solve, and attaining the proper balance between in-house and contractor effort.

Frosch discussed the proper role of NASA in future operational systems. He saw no great difficulty in NASA's taking on certain operational jobs with judicious interpretation of the Space Act. The question remained of NASA's operating national systems in a given part of the U.S. government. NASA's R&D effort in applications satellites was leading, Frosch said, "into an evolving global information system. But if . . . it is to become useful, then it will have to be an operating system. I think we are going to play two roles in such a situation: one of these is to do the R&D to improve such a system, and the other is to take the leadership role of making sure that the valuable research gets turned into an operational system which delivers data in a reasonable way."

Frosch concluded that, although NASA does not want to be the ultimate operator of such a system, it might have to do so in the early stages: that is, NASA would be an initial operator with the intent of transferring the system to another operator, either another government agency or a contractor. "Temptations posed by continuing large and everyday operations might lead us into difficulty in remaining a lively R&D organization." (*Goddard News*, Apr 78, 1)

• NASA's struggle to save 3 astronauts trapped in a foundering spaceship during the flight of *Apollo 13* had begun the most harrowing 6 days in NASA's history, *NASA Activities* reported in observing the 8th anniversary of the flight. The astronauts had heard a loud bang; when Fred Haise, Jr., scanned the instrument panel, he saw that one of the main electrical systems was deteriorating. The words Jack Swigert spoke to mission control long haunted NASA: "Houston, we've got a problem."

At the time of the explosion, *Apollo 13* traveling at 2100mph was 205 000mi from earth and more than 50 000mi from the moon, with a dead mothership (Odyssey) that included the main propulsion engine. After moving the astronauts into the lunar module, NASA focused on getting the Apollo on course for home while conserving limited supplies of power, oxygen, and water. Not only had NASA employees worked round the clock, but also specialists and computers from North American Rockwell, the contractor; Grumman Aerospace Corp., manufacturer of the LM; TRW Systems, builder of the descent propulsion engine; and many others. NASA had decided to drop the service module and put the command module Aquarius into the correct attitude for earth-atmosphere reentry; when the latter entered earth's gravity 216 277mi from home, it needed another course correction. The third descent-engine burn was successful, putting Aquarius into the proper reentry corridor.

As the spacecraft drew closer to splashdown, one of the astronauts described to ground control what he was seeing: "There's one whole side of that spacecraft missing . . . right by the high-gain antenna, the whole panel is blown out, almost from the base to the engine . . . it's really a mess . . . man, that's just unbelievable—looks like a lot of debris is just hanging out of the side near the S-band antenna." The astronauts had returned safely to earth 142hr, 54min, 41sec after launch. As Jim Lovell said, "We do not realize what we have on earth until we leave it." (*NASA Actv,* Apr 78, 14)

• NASA announced 3 key personnel changes during April: Dr. William Schneider would become associate administrator for space tracking and data systems, responsible for planning, development, and operation of global tracking networks, facilities, and systems for communications and data acquisition and processing for all NASA spaceflight programs. Dr. Schneider had joined NASA and the Gemini program in June 1963, after 2yr as director of space systems at ITT's Federal Laboratories. He had been mission director for 7 of the 10 manned Gemini missions, and had received NASA's Exceptional Service Medal for his service as deputy director of the Gemini program. He had also been mission director and program deputy director for the Apollo mission, and had received NASA's Distinguished Service Medal for his contribution to the success of the Apollo 8 mission.

At the end of Apr., Clarence Syvertson had become director of ARC, where he had served as acting director and deputy director. Syvertson had begun with the NACA at ARC in 1948 as a research scientist and assistant branch chief, then chief of the Hypersonic Wind Tunnel Branch, and later was director of the Mission Analysis Division. In 1966 he had become ARC's director of astronautics, a position he held until appointed deputy director. Syvertson had received NASA's Exceptional Service Medal for leadership of the joint DOT-NASA Civil Aviation R & D Policy Study, and in 1976 had been named a fellow of the American Institute of Aeronautics and Astronautics.

R. D. "Duff" Ginter, assistant associate administrator for energy programs in the Office of Aeronautics and Space Technology, had announced he would retire in June after 28 years of government service with NASA and the U.S. Navy. Ginter's contributions to space solar power, photovoltaic developments, wind energy systems, and automotive propulsion had placed him in the forefront of advanced technology applications. Ginter had begun his career with NASA in 1960 as chief of the Scout vehicle program. He later held several positions including director of the Centaur program, for which he received NASA's Exceptional Service Medal; director of the Technology Applications Division; director of the Energy Systems Division; and assistant administrator for energy programs. (NASA anno April 3, 10, 26/78; NASA Release 78-57, 78-65, 78-52; ARC Release 78-16)

• The Air Force Systems Command noted that Atlas launches planned at Vandenberg AFB as well as at Cape Canaveral in 1978 would use one of the oldest booster systems still working: first use of Atlas as a launch vehicle was in 1958. Atlas launches planned from Space Launch Complex 3 would support the USAF NavStar global-positioning system and space-test program; 2 NASA-sponsored satellites, Sea Satellite-A (SeaSat) and Tiros-N, would also use Atlas vehicles. (AFSC *Newsreview,* Apr 78, 3)

• The Air Force Flight Test Center at Edwards AFB, Calif., was target site for a Navy Tomahawk cruise missile successfully launched from a submarine, the USS Barb, a major milestone in the cruise-missile development program, AFSC *Newreview* reported. The test off the coast of southern Calif. was the Tomahawk's 24th, and its first launch from a submarine. The missile flew a fully guided land-attack test flight terminating at AFFTC. Objectives accomplished in the test included underwater ignition of Tomahawk's solid-propellant boost motor, and a midair engine start of the missile's turbofan engine for cruise flight. An onboard inertial-navigation set guided the missile to the Pacific coastline; once over land, the missile's terrain-contour matching system guided it to a recovery area. The flight ended with deployment of the test missile's parachute over a remote section of the test center; the missile, recovered by Navy personnel with AFFTC assistance, would be reused in future tests. (AFSC *Newsreview,* April 78, 11)

• Decisions not yet made by the U.S. government would determine the U.S. aerospace industry's fate for years to come, said Aerospace Industries Association president, Karl Harr, Jr., in the AIA's *Aerospace Review and Forecast, 1977.* Aerospace-industry sales in 1977 had increased appreciably, if not dramatically, in comparison with the previous year. Profit as a percentage of sales had climbed half a percentage point but remained below the average for all U.S. manufacturing. The industry had anticipated similar sales gains in 1978 and expected space activity to continue at approximately the same rate. Military sales should top those of 1977.

The aerospace industry had pressed for elimination of barriers to "free and fair trade" in the General Agreement on Tariff and Trade (GATT) negotiations; foreign-government subsidy of their manufacturers had made them highly competitive. The U.S. government's attempts to control export of "strategically critical" technology could severely impact sales abroad. Other issues of concern to the aerospace industry were capital formation and dealings with the government such as renegotiation, overregulation, expanding paperwork, and government competition with industry. Harr said that negative decisions could lead to "forfeiture of the pre-eminent position the U.S. has long held in high technology." (*Aerospace*, Spring 78, 3)

- In 1909 the Aero Club of Great Britain had established prizes of $125 each for the first four 250-yd flights of a heavier-than-air craft and three prizes of $250 for a one-mile flight in a closed circle, the NAA newsletter observed, in noting the progress of aviation. The Royal Aeronautical Society had just announced the $200 000 Kremer prize for the first crossing of the English Channel west to east by a manpowered aircraft. The society also had offered a $20 000 prize to the first Britisher who could duplicate in a manpowered aircraft the course flown by the U.S. Gossamer Condor, a one-mile figure 8. (NAA newsletter, Apr 78, 1)

May

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May 1: Langley Research Center announced it had presented to Thomas Blackstock its first major award for an energy-saving proposal. LaRC Director Donald Hearth had presented Blackstock with a check for $1245, largest monetary award ever given at the center for a suggestion. Blackstock's idea was to upgrade the high-pressure air-supply system in the continuous-flow hypersonic tunnel so that it would run in an intermittent short-duration-flow blowdown test rather than in the longer duration continuous-flow mode. The tunnel, which represented LaRC's only large-scale Mach 10 aerothermodynamic-test capability, had been important to the Space Shuttle testing and would aid in developing low-cost advanced space-transportation vehicles. Blackstock's suggestion could save $30 000 the first yr without compromising the tunnel's research capability; LaRC's wind tunnels had consumed one-third of the electrical energy purchased by the center. (LaRC Release 78-24; *LaRC Researcher,* May 5/78, 1)

• In its report on U.S. R&D spending for 1979, the National Science Foundation pointed out that doubling of the nation's R&D expenditures since 1969 had been almost entirely attributable to inflation. However, the overall U.S. R&D effort had experienced real growth every year since 1975, mainly from increased emphasis on finding alternative energy sources; it had not provided major stimulus to economic growth or productivity in the short term. The federal government, currently supporting more than half the nation's R&D effort, had over the last decade emphasized civilian programs rather than defense and space. Largest federal R&D spending increases for 1978 and 1979 were expected in the energy and health areas.

During the 1970s, the U.S. had allocated proportionately less of the national R&D effort to basic research. Factors influencing this trend included the federal government's deemphasizing basic research in defense and space programs during the early to mid-1970s; the industrial sector's seeking quicker payoffs from R&D efforts aimed at a specific product or process, as opposed to projects with no specific commercial application; and universities' increased emphasis on applied research over basic research since 1970. (*NSF Highlights,* May 1/78, 1)

• *Av Wk* reported that the House of Representatives had authorized a $4.415 billion NASA budget that included $4 million for an option to

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purchase a fifth Space Shuttle orbiter, which President Carter had tried to defer. The House had not changed the authorization bill submitted by its committee on science and technology. House members had defeated an amendment by Rep. Ted Weiss (D-N.Y.) to delete funds for advanced supersonic-transport research, but had passed an amendment requiring the NASA administrator to report to Congress by Dec. 31, 1979, regarding NASA policy on conflicts of interest, standards of conduct, and financial disclosure. The House version of the NASA budget had represented a $43.7 million increase over the Carter budget.

The Senate Committee on Commerce, Science, and Transportation had approved a $4.388 billion NASA FY79 authorization that included $4 million for the fifth orbiter and an additional $7 million for manned-flight advance planning. Former Apollo astronaut Sen. Harrison Schmitt (R-N.M.) had helped convince the committee that NASA needed the $7 million increase to maintain a viable advance-planning program for manned spaceflight. Total Senate Commerce Committee authorization was $17 million higher than NASA's original $4.371 billion request to Congress. (*AvWk,* May 1/78, 22)

- Latest word on *Progress 1* refueling of the *Salyut 6* propulsion system in orbit indicated that redesign of the space station had been more extensive than the USSR had previously revealed, *Av Wk* reported. The Soviets had made a fundamental change in the station's rocket engine and fuel system by switching to pressure-fed from turbine-driven main engines, and adopting a common hypergolic propellant for both the main propulsion and reaction-control system engines.

Before *Salyut 6,* the Soyuz and Salyut propulsion systems had been the same: in the reaction-control system, hydrogen peroxide thrusters had provided attitude adjustments and hydrogen peroxide had also driven turbines pumping hypergolic oxidizer and fuel to the main propulsion system. Fuels in the main propulsion system were a form of nitric acid and of hydrazine. This arrangement had required 3 sets of propulsion lines and tanks: 1 for the hydrogen peroxide, 1 for the main-engine oxidizer, and 1 for the main-engine fuel.

Changing the *Salyut 6* had allowed both the main engines and the reaction-control thrusters to use propellants from the same tanks, permitting much simpler and more effective orbital refueling than if it had to include hydrogen peroxide. The change had required design of an entirely new internal-tanking and propellant-line fuel system, and development of the pressure-fed engines and the hypergolic-thruster system. The aft section of the station containing the main engines and a concentration of reaction-control-system engines could now accommodate docking at that end by a second Soyuz transport vehicle. The Salyut's standard forward port was able to accept both Soyuz and Progress-tanker spacecraft. (*AvWk,* May 1/78, 1)

May 2: NASA announced signing of an agreement with the National Eye Institute (NEI), Bethesda, Md., for laboratory and clinical tests of a new surgical instrument to remove hard cataracts. Lewis Research Center had developed the instrument jointly with Cleveland ophthalmologist Dr. William McGannon. The NASA-NEI program would include refinement of surgical techniques using the cataract instrument, and design and implementation of clinical trials.

The new instrument consisted of a surgical handpiece, a regulated flow system for infusing fluid, and a peristaltic outflow pump with necessary controls. The handpiece would use a high-speed air-turbine drive to power an auger-type cutter capable of both end and side cutting, rotating at speeds between 300 000 and 270 000rpm. The control system had a flow-sensing pressure regulator to maintain intraocular pressure under widely varying flow conditions. Use of the rotary cutting instrument would require only a small opening in the cornea, and should apply to the full range of cataract hardness. As part of the joint agreement, NASA and NEI announced that interested companies might apply for a nonexclusive patent license to manufacture and market the flow-sensing pressure regulator, which might be applicable to other types of eye surgery. (NASA Release 78-66; *Lewis News,* May 12/78, 1)

- NASA announced that Frank Nola, engineer at Marshall Space Flight Center, while working on a NASA solar heating and cooling project, had invented an inexpensive yet revolutionary device called a power-factor controller that could save energy used by billions of electric motors throughout the U.S. The small device would continuously determine the load on the motor to which it was attached by sensing shifts between voltage and current flowing to the motor. When it sensed a light load, it would reduce the voltage to the motor to the minimum required, with accompanying drop in current flow, minimizing power going to heat loss. A typical washing machine using a power-factor controller would drop its power usage from 160watts to about 55watts on an idling motor. Savings would be less on a loaded motor but, as most domestic motors never needed the full 125volts available, the power-factor controller could save up to 8% of the power used by a motor under heavy load. Energy savings for larger motors would be even more dramatic. NASA said patent licensing and technical information for Nola's invention would be available from the MSFC chief counsel. (NASA Release 78-67)

May 4: NASA reported that 8mo after launch and 8mo before beginning close Jupiter observations, *Voyager 1* had traveled nearly 555 million km (348 million miles) from earth and was then at a distance from the sun of about 3.1AU. Its velocity relative to the sun was about 19.9km (12.4mi) per sec.; time needed for one-way communications was 30min 45sec. On May 3, the Voyager had performed a midcourse correction of its Jupiter-bound trajectory, as part of a set of commands relayed to the craft Apr. 26.

NASA had constructed a model to investigate the sticking of *Voyager 1*'s scan platform. One possible explanation for the sticking was that a small piece of plastic from the scan-actuator locking mechanism might have lodged in the actuator's gear. Before moving the scan-platform on the Voyager into the position where it had previously stuck, NASA would try to reproduce the failure in laboratory tests and determine its effects. (NASA Mission Status Bulletin, May 4/78)

May 5: NASA announced appointment of Samuel Keller as deputy associate administrator for space and terrestrial applications (OSTA), succeeding Leonard Jaffe, who had been appointed special assistant to NASA's chief engineer. In his new position, Keller would be responsible for general management and direction of OSTA programs. He had held numerous management positions at Goddard Space Flight Center before coming to NASA Hq as assistant administrator for personnel programs; had worked in industry and government; and had been a pilot in the U.S. Air Force from 1956 to 1959. (NASA anno May 5/78)

- Dryden Flight Research Center reported it had aborted the first design-limit test of the parachute recovery system for the Space Shuttle's solid-fuel rocket boosters (SRB), when the 48 000lb dummy booster scheduled for airdrop from a B-52 flying over the National Parachute Test Range would not separate from its aircraft. After several unsuccessful attempts, pilots returned the B-52 to DFRC without incident and rescheduled the flight for the week of May 5. (*DFRC X-Press,* May 5/78, 2)

- The *W. Post* reported that a subcommittee of the House Appropriations Committee had cut NASA's budget, endangering 3 of the agency's most ambitious plans for the next 5yr: to search for life beyond earth, to keep the Skylab space station from falling back to earth, and to fly a rare joint mission with West Germany around the north and south poles of the sun.

The subcommittee had cut $1.4 million from NASA's request for $2 million to begin a program called SETI (search for extraterrestrial intelligence), in effect killing the program. A NASA official said the funds would not be enough "to start design work on the antennas we were going to use to listen for extraterrestrial signals." The subcommittee also denied NASA $20.5 million to use for Space Shuttle astronauts to fire the abandoned Skylab space station into a higher and safer orbit. NASA considered the most critical cut to be $5 million from the $13 million sought to start in 1983 the solar-polar orbiter mission that would have used two spacecraft, one built by the U.S. and the other by West Germany. The West Germans had warned that any U.S. delay meant that Germany would drop out of the mission. (*W Post,* May 5/78, A13)

• LaRC announced it would sponsor during May a program on "Women in Aviation," with slides and tapes highlighting women's contributions to aviation. An international organization of women interested in aviation, The 99s, which was founded in the 1930s and whose original members included Amelia Earhart and Anne Morrow Lindbergh, provided the program to LaRC. (LaRC Release 78-27)

May 8: LaRC announced that Donald Hearth, center director, had received an honorary Doctor of Science degree during commencement exercises May 7 at George Washington Univ. in Washington, D.C. As guest speaker, Hearth discussed Technology and the Future, noting, "There will continue to be a strong tendency to characterize technology as either the savior of society's problems or the villain in the drama of life. Technology is not magic," he continued, "but it can help solve some of society's problems. We want machines, but not the kind that run us. We want technology, but we want to be in charge of it." The address included a short history of technology, and projections of possible uses of technology in the near future. (LaRC Release 78-29)

• LaRC announced it would hold a conference on safety, occupational medicine, and environmental health May 15-18, with about 60 representatives from all NASA centers attending. Welcoming remarks by Fred Bowen, LaRC technical manager for management operations, would cover audiometric testing, types of hearing loss, rehabilitative techniques, noise protection equipment, and computerized treadmill data. LaRC Director Donald Hearth's remarks on the second day would include discussion of workmen's compensation, disability, continuation of pay status, and LaRC's occupational medicine and environmental health and safety programs. The May 17 agenda would cover space suit testing, new approaches in workplace health standards, fire protection, Space Shuttle safety challenges, the kinetic method of lifting, and system safety in wind-turbine generators. On May 18 participants would discuss nuclear safety in space systems, Space Shuttle occupant safety, and new firefighting equipment. (LaRC Release 78-28)

• The long controversy in the International Civil Aviation Organization over choice of a microwave landing system—which had ended in a 39-24 victory for the U.S.-backed time-reference scanning-beam (TRSB) system—had taught the group important lessons, *Av Wk* reported. First: the large turnout of Third World countries indicated that future proposers of new systems must focus their appeals to such countries. Roy

Cox, director of telecommunications for the British Civil Aviation Authority, described the problem: "Those . . . in the meeting faced the impossible task of studying and acting upon some 2,000 pages . . . on complex operational and technical issues and the time allotted did not permit adequate study by those states which had not previously participated in the many years of preparation." Second: although the ICAO had recognized the complexity of evaluating competing systems on the basis of extensive avionics expertise and background, 5 of the 10 specialists appointed to the All Weather Operations Panel had represented countries favoring particular microwave landing systems. Although selected as individuals, not as official representatives of their governments, the 5 had consistently favored the entry sponsored by their government. Hindsight would recommend including specialists from many countries on such an evaluation panel, to ensure that members predisposed to one of the choices would represent a minority, rather than a majority, of the panel. (*AvWk*, May 8/78, 44)

• Walter Morgan, ComSatCorp senior staff scientist, said at a conference sponsored by the American Institute of Aeronautics and Astronautics that a network of high-capacity comsats could be in orbit by the early 1990s, increasing transmission capacity and reducing the need for large ground antennas, *Av Wk* reported. Called orbital antenna "farms," the 14 000lb clusters of communications satellite antennas and sensors could replace many smaller individual satellites in geostationary orbit. Five antenna farms linked together in circular fashion would form a major cluster, which in turn could make up 1 part of a network of 5 separate clusters serving the Americas, Europe, the Pacific, Africa and the Middle East, and Asia. Such antenna farms would reduce the number of individual satellites and emit higher powered radio frequencies, permitting numerous earth stations to have smaller antennas with attendant lower costs and greater mobility.

Basis of an antenna farm cluster would be a structure about 40ft long and 14ft in diameter, housing electronic modules to control mission-payload equipment. Although current technology was capable of handling orbital antenna farms, two possible technological problems would be in-orbit construction of the platforms and in-orbit servicing of the equipment. Disadvantages would include compromises on optimum orbital locations for various missions, radio-frequency interference between payloads grouped on a common platform, and the effect of a single system's failure on other antenna farm systems. Although ComSatCorp had not taken an official position on the concept, Morgan predicted that an antenna farm could be operational in the early 1990s, and that a smaller experimental farm might be operating earlier. (*AvWk*, May 8/78, 56)

May 9: ESA announced that on May 12 the Villafranca del Castillo ground station near Madrid would be inaugurated by H.M. Juan Carlos, king of Spain. ESA had designed the station, built under an Aug. 2, 1974, agreement between ESA and Spain, to monitor and control the *IUE* satellite launched in Jan. 1978, OTS-2 to be launched the first half of May, and Marots to be launched in 1980. The station had antennas measuring 15m for *IUE*, 12m for Marots, and 3m for OTS-2. ESA also would use the station beginning the end of 1978 to control the U.S. meteorological satellite Goes. Like other ESA ground stations, Villafranca would be linked with the European Space Operations Centre (ESOC) at Darmstadt in West Germany, which housed control and computer facilities for all European satellites. (ESA Release May 9/78)

May 10: MSFC announced that its weather scientists working with colleagues from Texas A&M had encountered practically every kind of severe weather—thunderstorms, tornadoes, torrential rains, hail, and snow—within the study of the zone, roughly the south central states, during the 7th atmospheric variability experiment (AVE-7). As a 3-day weather pattern had moved across the test area, 24 rawinsonde stations operated by NOAA and one each by MSFC and Texas A&M had acquired data. The experimenters had also received for comparison a weather picture from a Goes satellite every 15min and reports from weather radars throughout the area every hour.

In the AVE-7 experiment, rawinsonde stations every 3hr released balloons carrying instruments to record temperature, humidity, atmospheric pressure, and wind velocity and direction from ground level to an altitude of about 25km (15.5mi). The balloons, normally released about every 12hr, on a 3-hr schedule had allowed researchers to spot small-scale events that could dissipate quickly. The balloon data, combined with satellite pictures at 15-min intervals, had permitted computerized weather forecasts by showing scientists how to spot approaching bad weather much earlier; comparison of ground-based with satellite data would help identify the causes of severe weather. With more such experiments using space technology, scientists could eventually accumulate enough information to more accurately predict severe weather. (*Marshall Star*, May 10/78, 1)

• MSFC announced it had awarded contracts totaling $42 751 900 for scientific investigations in support of the Space Telescope project to five educational institutions: Research Foundation of the State Univ. of New York, Albany, Dr. J. J. Caldwell, Space Telescope interdisciplinary scientist, $126 000; Beloit College, Beloit, Wis., Dr. D. J. Schroeder, telescope scientist, $69 000; Institute for Advanced Study, Princeton, N.J., Dr. J. N. Bahcall, interdisciplinary scientist, $257 700; Johns

Hopkins Univ., Baltimore, Md., Prof. W. G. Fastie, telescope scientist, $151 300; Univ. of Texas, Austin, Dr. William Jefferys, astrometry science team leader, $1 862 500; and Dr. K. L. Lambert, interdisciplinary scientist, $285 400.

The Space Telescope, planned for launch into earth orbit in the early 1980s, would permit scientists to see 7 times farther into deep space than before. MSFC had been lead center for the Space Telescope; GSFC had been responsible for scientific instruments and for planning telescope operations. (*Marshall Star,* May 10/78, 2)

- To put space processes and space products within public reach as early as possible, NASA had sought private firms to do materials processing in space, MSFC reported. The center had named a special task team to work exclusively with firms interested in pursuing space-made or space-derived processes and products; the team, headed by Richard Brown, would be the point of contact for information and assistance to firms with ideas for new or improved products that might be processed in space. "We intend to develop simplified working arrangements," Brown said, "and make it as easy as possible for commercial firms to try out new ideas for materials processing in the space environment."

Promising results from earlier space experiments, coupled with the opportunity offered by the Space Shuttle to work routinely in space, could make material processing commercially attractive. According to Brown, gravity reduced to a millionth of that on earth could make "interesting things" happen: elimination of the forces of buoyancy, sedimentation, and movement in fluids caused by heat could permit uniform mixing or separation of materials that would be impossible on earth. Families of new materials might be derived from materials processed in space.

To reduce industry's initial capital outlays usually needed for joint ventures, NASA had planned to build an inventory of general purpose processing hardware for lease to any U.S. firm, institution, or individual that would conduct materials experiments or demonstrations consistent with NASA's objective of public benefit. Brown had invited anyone interested in the program to ask MSFC's task team for more information. (*Marshall Star,* May 10/78, 4)

May 12: NASA announced launch of ESA's orbital test satellite 2 *Ots 2* at 6:59pm EDT, May 11, from Cape Canaveral toward a stationary orbit 22 300mi over Gabon in West Africa. A Delta vehicle had put the satellite into synchronous-transfer orbit with apogee of 36 042km, perigee of 185km, and inclination of 27.4°. An apogee boost motor fired 37hr after launch at fifth apogee had circularized the orbit so that *Ots 2* could drift to its final location above the equator at 10°E. *Ots 2* would remain for 6 or 7yr relaying telecasts among nations of the European Broadcast Union and carrying as many as 7000 telephone calls at a time.

This new comsat was one of two experimental models built by ESA to test performance in orbit; their descendants, European operational comsats, would serve in the 1980s as satellite links for intra-European telephone, telegraph, and telex traffic and would provide western Europe with television relay.

The first launch of an Ots from Cape Canaveral Sept. 13, 1977, had failed when the Delta first stage exploded 55sec after liftoff. The probable cause (burn-through of a solid-propellant strap-on Castor IV motor at the bottom of the first-stage Thor booster) had been avoided for further flights by increasing the thickness of insulation between the solid propellant and the exterior motor case.

Industries in Belgium, Denmark, France, Germany, Italy, Netherlands, Sweden, Switzerland, the United Kingdom, and Spain had built the spacecraft under ESA supervision; prime contractor was British Aerospace Dynamics Corp. Under an agreement with the U.S., ESA would reimburse NASA for the cost of the Delta launch vehicle, launch services, and other administrative costs totaling $417 million. GSFC had provided technical direction of the Delta project; Kennedy Space Center's expendable vehicles directorate was responsible to GSFC for launch operations. (MOR M-492-210-78-02 [prelaunch] Apr 27/78; NASA Release 78-53; *W Post,* May 12/78, B-6; ESA Release Apr 7, 12/78; May 8, 17/78)

- Jet Propulsion Laboratory announced it had agreed to participate during May in an experiment called Avefria (Spanish for lapwing) to perturb the atmosphere so that scientists could study ionospheric irregularities and their effects on radio communications. The experiment would create a high-altitude barium-ion cloud in the ionosphere (an atmospheric layer 25 to 250mi above earth in which radio signals typically travel for long distances) by rocket-borne release of barium-metal vapor. Optical-observation and radio-communications stations in Nev. would make scientific measurements of the cloud and its interaction with the ionosphere. Major observation point would be the Tonopah (Nev.) Test Range; JPL would operate a second observation station at its Table Mountain astronomy site near Wrightwood, Calif. (*JPL Universe,* May 12/78, 1)

- NASA announced Lockheed Missiles & Space Co. biotechnologists and engineers would use frogs on the Space Shuttle as research subjects to study inner-ear balance as the cause of space sickness that had afflicted some astronauts. Under a 6mo contract with Ames Research Center, Lockheed researchers would first study the behavior in space of the frog's otolith nerve bundle, which closely resembled man's. Microelectronic sensors inserted in the frogs would periodically feed data into recorders on the ground and in space. Preflight ground-based tests using a centrifuge would furnish baseline data to compare with information obtained in weightlessness. (*JSC Roundup,* May 12/78, 4; *NASA Act,* May 78, 10)

May 15: NASA announced it would participate in a joint American-Soviet particle-intercalibration (JASPIC) project to compare techniques used by both countries to measure intensity of energetic electrons and protons entering the lower ionosphere. At a 1975 meeting of the International Union of Geodesy and Geophysics in Grenoble, France, U.S. and Soviet scientists had agreed that the first question to be resolved was instrument credibility. Joint measurement of energetic electron and proton intensity at the same time and same place would be a first step in reconciling the conflicting results reported in the scientific literature. A Soviet research ship, the Professor Vize, off the Va. coast near Wallops Flight Center would serve as the Soviet launch platform.

The researchers would study the role of the particles in creating ionization in the lower ionosphere at night at mid-altitudes. They would compare data from 4 sounding-rocket launches from Wallops Island and 5 Soviet MR-12 rocket launches from the ship. One of the Wallops-launched rockets would release a chemical cloud possibly visible to east coast residents. Each organization would be responsible for its own countdown and launch operations. (NASA Release 78-71)

- LeRC announced it had signed a memorandum of understanding with the Papago tribe of Ariz. and the U.S. Public Health Service to provide the Papago Indian village of Schuchuli, Ariz., with electric power from the sun by Sept. 1978. This would be funded by DOE as a first step toward construction of a 3kw totally solar electric village power system, part of DOE's Natl. Photovoltaic Conversion Program. The new system would provide Schuchuli's 96 residents with sufficient electricity to power a community refrigerator, freezer, washing machine, sewing machine, water pump, and lights for the village's 16 homes, church, and feast house. Under the cooperative agreement, NASA would furnish all materials and technical assistance necessary to install the equipment and supporting facilities. The Papago Construction Co., an arm of the Papago tribal council, would erect the solar arrays and install all power-system equipment. (NASA Release 78-70; *Lewis News,* May 26/78, 1; DOE Release ET-0044/2)

- *Av Wk* reported that a long deadlock on airline regulatory reform had been broken when the House Transportation and Public Works aviation subcommittee approved a bill consigning automatic route entry to further study before planning a permanent program. The White House had wanted a strengthened bill from a joint House-Senate committee. The Senate-passed bill had allowed an airline one new route in the first 2yr after the bill became law in 1979, and two new routes in each of the following 3yr. The House bill approved by voice vote had allowed a carrier one new route in the first calendar yr after enactment, as well as designation of one market, disallowing automatic entry to a competitor.

The bill would have required the CAB to complete a study on success of automatic-entry provisions by June 30, 1980; if that study should find the experiment successful, Congress would pass additional legislation for airline deregulation on a more permanent basis. A compromise bill pushed by the Carter Administration would terminate the CAB, continue the small-communities subsidies, and give U.S. international carriers fill-up rights to carry domestic traffic on all international routes, among other provisions. (*AvWk,* May 15/78, 26)

• Congress had remained divided over continuing the separate development by the Army and the USAF of two battlefield nuclear weapons for a similar purpose: delivery of quick-reaction nuclear strikes to free for other missions the dual-capability NATO aircraft now committed to nuclear alert, *Av Wk* reported. The Army had been working with Martin Marietta on the Pershing 2 mobile tactical nuclear ballistic missile; the USAF had been working with General Dynamics on the Tomahawk ground-launched cruise missile.

The House Armed Services Committee had asked the Pentagon to make an early decision on one of the two weapons for the European theater. The committee would have to take into consideration transferring the Pershing 2 program to the USAF and halting the ground-launched cruise-missile production program; adding $10 million to the $10.1 million requested for the Pershing 2 in recommending program transfer to the USAF; the questionable survivability of the ground-launched cruise missile, and the capability of Pershing 2 to penetrate 1980's Soviet air defenses; and development studies by the USAF of at least two ballistic missiles, at the time it was requesting ground-launched cruise-missile production funds. The Senate Armed Services Committee had recommended continuing the Pershing 2 under the Army program office, and providing full funding for the USAF ground-launched cruise missile. The House and Senate now had to seek a compromise on the two systems during a conference scheduled for late May or early June. (*Av-Wk,* May 15/78, 18)

• ComSatCorp had agreed to a 48% reduction in its rates for international satellite communications, following FAA approval of a proposed settlement of its 13-yr-old rate case, *Av Wk* reported. ComSatCorp management and FCC staff had agreed on settlement last Feb. As U.S. representative to the 102-nation International Telecommunications Satellite Organization (INTELSAT), ComSatCorp had leased capacity on INTELSAT circuits to other U.S. carriers such as American

Telephone & Telegraph, ITT World Communications, RCA Global Communications, and Western Union International. The FCC now had to decide how these carriers would pass rate reductions along to their customers.

As part of the settlement, ComSatCorp would relinquish all claim to an escrow account totaling more than $100 million that it had set up in mid-1976 pending judicial review of an FCC Dec. 1975 decision in the rate case. The amount in escrow had been set aside for possible refund of overcharges since mid-1976, and the FCC also had to decide how refunds would be made. Under the settlement, ComSatCorp's overall allowed rate of return would be 11.48%, compared to 10.8% under the FCC's 1975 decision. (*AvWk,* May 15/78, 22)

May 16: NASA announced it had awarded Pratt & Whitney Aircraft Group of United Technologies Corp. an $80.4 million contract for advanced technology to improve fuel efficiency in future turbofan engines. Options in the contract could raise its total value to $94.4 million. This effort, a cooperative government-industry technology program to reduce fuel consumption in future turbofan engines by 10 to 15%, while also reducing direct operating costs, emissions, and noise levels, would constitute the major part of the energy efficient engine project, an element of NASA's aircraft energy efficiency (ACEE) program. At the end of the 5-yr technology contract, Pratt & Whitney should be able to begin development of advanced commercial turbofan engines for airplanes flying in the late 1980s and early 1990s. NASA had signed a similar technology-development contract with General Electric. (NASA Release 78-74)

May 17: MSFC announced it had begun preparations for stress tests of the Space Shuttle orbiter at Lockheed-Calif.'s 430ton (390 metric tons) steel test rig at Palmdale, Calif. The 6-story "reaction frame" rig had more than 350 hydraulic jacks exerting loads on the orbiter to simulate those to be encountered at launch, during spaceflight, and on reentry into earth atmosphere. Lockheed would perform the tests under contract to Rockwell Intl., builder of the orbiter. (*Marshall Star,* May 17/78, 2)

- Johnson Space Center announced it would sponsor a 2-day conference with the Univ. of Texas health science center on ways to use spaceflight in biomedical research. The first session, entitled Space: A Challenge for the Life Sciences, would have as speakers the JSC director, Christopher Kraft, Jr.; NASA's director for life sciences, David Winter, M.D.; JSC director of space and life sciences Richard Johnston; and Univ. of Tex. health science center resident Truman Blocker. The conference would conclude with a panel discussion on spaceflight applications. (JSC Release 78-19)

• The *W Star* reported that spokesmen for four government agencies using portable nuclear-power generators could not respond immediately to charges that the federal government lacked adequate control over the use or whereabouts of such devices. Charges came from members of the House Commerce Committee who said the public had not been informed of potential hazards to health, safety, and the environment posed by the devices or how they were used.

Committee members had sent President Carter a letter asking for a public accounting of portable nuclear devices used by the U.S. around the world. Of major concern was a device called SNAP (system for nuclear auxiliary power) generating from any of three radioactive and highly toxic fuels—cesium, strontium, or plutonium—heat that the device could transform into electricity for satellites or other remote power needs. Designed in the early 1960s primarily as a power source for space satellites, SNAPs had later been applied to terrestrial uses including a CIA project in which a SNAP, left on a Himalayan mountain to monitor China's missile testing, was apparently buried by an avalanche.

After a 1964 mishap when an Air Force spy satellite powered by a SNAP reentered and burned over the Indian Ocean, spreading radioactive fallout over a wide area, DOD had ordered manufacture of SNAPs in case-hardened containers that would remain intact if a satellite carrying one should fall from orbit. In 1968, a rocket launching another spy satellite from Vandenberg AFB had misfired and dropped two SNAP generators into the Pacific just off the southern Calif. coast; a 6mo search had recovered the SNAPs. (*W Star,* May 17/78, A-18)

May 18: NASA had officially changed the date of the first Space Shuttle orbital flight from Mar. to June of 1979 because of engine problems, the *NY Times* reported. NASA said the June date would be tentative until additional tests confirmed that the Shuttle's three main engines were free of problems. There had been signs the engine situation was improving. Launch date had been important because of NASA's plan to use the Shuttle to rescue Skylab from an uncontrolled fall to earth next year, possibly by early summer. (*NYT*, May 18/78, B-10)

• The *NYT* reported a leading Soviet astrophysicist's forecast that the next 250yr would see construction of a vast "artificial biosphere" in outer space capable of supporting 10 billion people, more than twice the world's present population. Iosif Shklovsky had visualized a system of space colonies with total surface area hundreds of thousands of times greater than earth's, that could capture and use huge amounts of solar energy. Looking further into the future, Shklovsky had also predicted that 2540yr from now mankind would have fully colonized the solar system.

His article in the journal *Social Sciences* emphasized U.S. plans to use large satellites to beam solar energy to earth as microwaves. Prof. Gerald O'Neill of Princeton Univ., head of a group of physicists and engineers designing solar satellites, had estimated that a space colony accommodating 100 000 or more people could be built by the year 2025. Skhlovsky had agreed that expansion into space would be inevitable because of mounting pressures of population and environment on earth's resources. Only the colonizing of space could offer a long-term solution, Shklovsky contended, claiming mathematical proof that adopting a global-balance strategy of limited growth could delay, but not avert, a world crisis. Shklovsky added that construction of large-scale colonies would require raw materials from the moon, asteroids, and other planets.

Although other Soviet scientists had stressed the importance of the search for extraterrestrial life, Shklovsky said that chances of finding other intelligent life were extremely remote. The distance to the nearest extraterrestrial civilization (one whose signals could be reaching the earth now) had been calculated at 3300 to 9800 light yr, or 19 800 trillion to 58 800 trillion mi; however, the absence of life, at least intelligent life, in earth's region of the universe should not discourage, but rather encourage, the conquest of space, he said. (*NYT*, May 18/78, B-10)

May 19: NASA announced plans to launch the geostationary operational environmental satellite GOES-C, third in a series of operational spacecraft funded by NOAA to meet DOC requirements, no earlier than May 25, 1978, from the ETR on a 3-stage Delta. In May 1974 and Feb. 1975, NASA had launched two operational prototype meteorological spacecraft, *Sms 1* and *Sms 2*, developed with NASA funding and still in orbit; it had launched the first two operational spacecraft funded by NOAA, *Goes 1* and *Goes 2*, in Oct. and June 1977, respectively.

NASA had planned to use a 3-stage inertially-guided Delta launch vehicle to inject GOES-C into a transfer orbit where its apogee boost motor would put it in a synchronous orbit. A GOES-C on station at 135°W would augment existing satellite coverage of earth weather and become a part of the Global Atmospheric Research Program (GARP). (MOR E-612-78-01 [prelaunch] May 19/78)

• NASA announced that Kenneth Chapman, associate administrator for external relations since Jan. 1978, had resigned from NASA to join Vought Aircraft Co., Dallas, Tex., as vice president for market research and analysis. Chapman had assumed his NASA position in Jan. 1978. Before joining NASA, Chapman had been director of nuclear material safety and safeguards at the Nuclear Regulatory Commission. He was a retired Air Force major general. (NASA Release 78-78; NASA anno May 18/78)

May 21: FBIS said Tass had commented on the upcoming U.S. launch of

Pioneer Venus-A, noting that the orbiter's radar resolution would permit it to transmit only an approximate map of Venus that would show only very big objects. Tass had pointed out that the mission would not include soft landing or transmission of photographs from the surface of Venus as the Soviet *Venera 9* and *Venera 10* had, because Pioneer Venus-B (the lander) would not survive landing and all transmission of information would stop. (FBIS, Tass in English, May 21/78)

May 22: NASA reported it had successfully conducted the second of two chemical-cloud experiments from WFC at dawn on May 22; it had launched the first at 5:29am EDT May 20. The launches had been designed to measure turbulence transport in the stratosphere by observing chemical vapor trails at an altitude of between 15 to 50km (9 to 31mi). Two-stage Nike sounding rockets had released vapors of titanium dioxide particles in spurts at 10-sec intervals, forming a series of dashes similar to an aircraft contrail; ground cameras had recorded the dispersion of the vapor trails. (WFC Release 78-4, 78-6; NASA Release 78-73)

• French and West German space officials had told a House committee that increasing costs would limit use of the U.S. Space Shuttle and the European Spacelab, *Av Wk* reported. A NASA official had admitted that Spacelab could have been built less expensively under a single nation's management, but denied that Space Shuttle operational costs had increased prohibitively.

Wolfgang Finke, director of West Germany's Dept. of Space and Transportation, told the House Committee on Science and Technology that not only had the price of conventional launches increased steadily, but also "the new space transportation system will not revolutionize the cost of space transportation. On the contrary, the estimates for the fare of a Shuttle roundtrip and the fringe costs going with it went up considerably, putting a real brake on our more ambitious plans to utilize the new system." As for Spacelab, Finke said the results of a West German materials-processing experiment would need a series of experiments for confirmation, with a cost level "well above the range of traditional materials research costs."

Hubert Curien, president of the French space agency, said that "anticipated cost of Spacelab experiments now reaches such heights that their funding raises very serious problems for national budgets and constitutes a very severe limitation." Finke noted in conclusion that administrative costs of international cooperation had increased costs of the overall project. A NASA official agreed that if Spacelab had been built in the U.S. under one management, total cost would have been less. (*Av-Wk*, May 22/78, 28,

• *Av Wk* reported that U.S. Air Force ground controllers had begun to bring the second NavStar global-positioning system satellite up to full operational status, after its successful launch on an Atlas F May 13 from Vandenberg AFB. The 955lb spacecraft had gone into an 85 × 10 900nm elliptical orbit, and its solid-fuel rocket motor had fired 2days later, putting it in a circular orbit; thrusters would shift it to its final station. Modifications of the rubidium-vapor atomic clocks had delayed launch of *NavStar 2* for a day; when ground tests indicated a malfunction of the NavStar frequency-divider circuit, the USAF had ordered modifications of all three clocks on *NavStar 2* to prevent a similar occurrence in orbit. The USAF planned to launch a third NavStar from Vandenberg in Aug. (*AvWk*, May 22/78, 24)

• *Av Wk* reported that the House of Representatives had committed the U.S. to membership in Inmarsat, the $200 million 40-nation international maritime-satellite organization, and had designated ComSatCorp as the U.S. representative. The Senate Commerce Communications Subcommittee had completed hearings and was expected to approve similar legislation shortly. A protracted controversy had gone on within the government and among international telecommunications carriers over the entity or combination of entities that should represent the U.S. in an organization to own and operate a global satellite-communications system for ships. Other nations had not encountered this problem, because their communications entities were all government agencies anyway.

Two documents establishing Inmarsat had opened for signature Sept. 3, 1976: a statement of organization policies and structure, and an operating agreement calling for initial $200 million capitalization. The U.S. and other participating governments would sign the former; ComSatCorp, under the House-passed legislation, would sign the latter. The 40 nations planning to join would divide investment initially according to anticipated usage, later according to actual usage. ComSatCorp would finance $34 million, the U.S.'s initial 17% of the capitalization. Nations that would account for 95% of the initial investment had to sign by a July 3, 1979, deadline, or the Inmarsat documents would be void. As the documents would take effect 60days after, by Sept. 3, 1979, Inmarsat would be either operative or dead. (*AvWk*, May 22/78, 21)

• U.S. share of the 102-nation INTELSAT organization had dropped from its 61% starting point in 1964 (when 19 nations had joined to establish a global communications consortium) to 25.1%, *Av Wk* reported. Charges that the U.S. had dominated INTELSAT had caused friction in the organization since its inception. The 1964 interim agreements had ensured U.S. majority ownership of not less than 50.6%; expanded membership and traffic patterns had decreased U.S. control as well as the friction. Other ownership shares under the new allocation were those of the United Kingdom, 10.8%; France, 5.98%; Brazil, 4.23%; and Japan, 3.68%. The 1964 interim consortium had been capitalized at $200 million; the 1971 agreements had boosted the figure to $500 million, including members' net capital contributions and the outstanding contractual capital commitments. The amount had reached $900 million in 1976 to finance Intelsat V satellites. (*AvWk,* May 22/78, 56)

May 24: MSFC reported it had successfully conducted a first major test firing of the three Space Shuttle main engines during a 15sec run at the Natl. Space Technology Laboratories in Bay St. Louis. MSFC had already successfully fired one of the modified engines for 520sec at 100% thrust, more power than needed for the first Shuttle mission. Test results would aid in establishing countdown procedures. More than 300 contractor and NASA employees had worked on the test series, described by program officials as the most complex large propulsion-system evaluation undertaken in the U.S. space program. Test budget for firings and facilities was $52 million.

Main propulsion-test articles were the Martin Marietta external tank containing propellant for firing tests, just as it would during Shuttle missions; the Rockwell Intl. orbiter simulator; three Rocketdyne main engines; and the Rockwell Intl. shuttle avionics test set, replacing the Shuttle-orbiter computers during tests. Key Shuttle launch and flight parameters to be verified by propulsion-test data were the cryogenic boiloff rate of external-tank propellants on the launch pad; rate of external-tank self-pressurization; engine-prestart requirements, such as pressure and temperature milestones; starting, throttling, and cutting off the engine, using external-tank propellants with the engines operating in close proximity; engine gimbaling; control-system response; loads placed by the engines on the orbiter; and launch acoustic data. Flight-dynamics engineers had been especially interested in verifying control-system models with the main propulsion-test data.

Test 1, scheduled for 2.35sec, had been terminated at 1sec because of an instrument problem. Test 2, scheduled for 15sec with the engines at 70% thrust, would assess propellant-flow paths from the tank through the orbiter and into the engines under thrust conditions. Test 3, planned for 15sec at 90% thrust level, would reverify overall propellant-system operation, and effect of the engine plumes on the test stand's flame deflector. Test 4, planned for 40sec at 90% thrust, would define propellant flow and flame-deflector hot spots. Firings 5 through 7, lasting 500 to 600sec, would duplicate Shuttle flight profiles; firings 8 through 10 would run for long durations with flight-rated 77:1 nozzles; and firings 9 through 13 would have the 35:1 nozzles reaffixed for engine throttling, to demonstrate the effect on flight profiles.

Although the main engine had taken the blame for Shuttle launch-date slip, the external tank and solid-fuel rocket booster tests also had failed to support a March launch. (*Marshall Star,* May 24/78, 1, May 17/78, 1; *JSC Roundup,* May 12/78, 1; *AvWk,* May 22/78, 55; May 29/78, 49)

- NASA announced that, as interrogations from tracking stations in Mar. and Apr. had successfully made contact with Skylab, the agency would begin in early June to uplink from JSC mission control a series of Skylab attitude-change procedures to put a new program into Skylab's onboard computer. The attitude-control system would be used to maneuver the spacecraft into the desired position and operate the control-moment gyros to keep it there. The procedures establishing control of Skylab, to be completed by mid-June, might extend its orbital lifetime by 6 to 12mo. The attitude change, if successful (and if the gyros continued to operate), could delay Skylab's reentry into the atmosphere until late 1979 or mid-1980. The maneuvers would decrease atmospheric drag on the spacecraft by aligning it with the flight path; once in the desired attitude, Skylab could survive from day to day without further maneuvers or adjustments. (JSC Release 78-20; *JSC Roundup,* May 26/78, 1; *Marshall Star,* May 24/78, 1)

- MSFC reported that a patent had been issued for a reel mechanism and associated control system invented by MSFC employees Ralph Kissel and Charles Rupp for the Shuttle tethered satellite system (TSS). NASA had considered the TSS as a means of enhancing Space Shuttle performance of scientific investigations and operational activities in space. The system would use a flexible tether line to deploy and retrieve subsatellites at distances as great as 100km from the orbiter. NASA had judged the mechanism and control-system invention would contribute significantly to overall feasibility of the TSS concept. (*Marshall Star,* May 24/78, 4)

May 25: NASA announced that *Heao 1,* first of a series of observatories designed to study celestial x-rays and gamma rays, was officially a success. Primary objective of *Heao 1* was to obtain highly detailed experimental data on astrophysical phenomena by measuring sizes and locations of x-ray sources and determining their intensity and time variation; according to Dr. Noel Hinners, NASA associate administrator for space science, the objective had been accomplished. NASA had authorized an extension of *Heao 1*'s mission to a second scan of the celestial sphere, and would broaden scientific participation through a guest-investigator program. NASA planned to launch in Nov. 1978 a second high-energy astronomy observatory designed for detailed study of interesting sources pinpointed by *Heao 1*; a third would be launched in 1979. (NASA Release 78-80)

May 26: NASA reported it had halted MSFC preparations for vibration tests of the Shuttle orbiter Enterprise May 12, when the upper dome of the prototype liquid oxygen tank buckled inward while being filled with water. Pressurizing the tank to 1lb later removed the wrinkles. The tank implosion would delay Enterprise vibration testing, but the program office would have to review delay of the overall Space Shuttle program. (*JSC Roundup,* May 26/78, 1; *Marshall Star,* May 10/78, 1)

- NASA announced it had postponed to at least June 24 the scheduled June 10 launch of SeaSat-A because of precautionary changes and tests on the Atlas F launch vehicle. Temperature increases in the aft sections of recently launched Atlas vehicles had necessitated the changes and resulting tests.

NASA would use SeaSat-A, first satellite designed to study the world's oceans, to see if microwave instruments scanning from space could provide scientific data useful to oceanographers, meteorologists, and commercial users of the seas. The spacecraft would send information on sea-surface winds and temperatures, currents, wave heights, ice conditions, ocean topography, and coastal storm activity.

NASA would attempt to demonstrate the feasibility of an operational multiple-satellite network to monitor oceans on a continuous near-real-time basis; twice daily, the system could provide ships at sea with detailed charts updated to show latest weather conditions, sea states, and hazards. Long-range use of the system could influence ship design, port development, and selection of sites for offshore facilities such as power plants. Other potential users of SeaSat data would include commercial fishermen, oil exploration firms, the Weather Service, pollution-control agencies, and the Coast Guard and Navy. (NASA Release 78-77; *JPL Universe,* May 26/78, 1)

- LeRC reported that the communications technology satellite *Cts,* world's most powerful comsat, had made possible quick diagnosis of burn and multiple-injury victims of a simulated catastrophe at the Baltimore/Washington International Airport. The Maryland Institute for Emergency Medical Services had conducted a disaster exercise called Emergency Management of an Airport Catastrophe as part of a 2-day seminar for physicians, interns, residents, nurses, and other health care professionals. The "disaster" (a simulated collision between a commercial airliner and a ground aviation fuel tanker) had tested airport and statewide emergency medical plans to aid the "injured," including about 180 crash victims. The scenario at the site included a breakdown in local communications, and an overload of local emergency medical facilities. A joint program between the U.S. and Canada, *Cts* operated on a new frequency at power levels 10 to 20 times higher than those of other satellites; the higher broadcast power had allowed use of much smaller and far less expensive ground-receiving equipment. (*Lewis News,* May 26/78, 2)

- JPL announced that more than 100 scientists from universities and corporations in the U.S. and Europe had attended its solar-probe science workshop at CalTech May 22–23 to discuss the proposed closest encounter with the sun. The proposed mission, being studied at JPL under NASA's Office of Space Sciences, would launch a uniquely designed spacecraft in 1985 into an orbit 2 100 000km (1.3 million mi) above the sun's surface, arriving in 1989. Scientists had theorized that the sun probe would yield valuable new insights into solar physics, providing data on solar wind, solar particles, the solar magnetic field, and interplanetary dust. The workshop had reviewed new technologies needed for a spacecraft orbiting so close to the sun. JPL had begun studies of a new heat shield design, a high-powered telecommunications system with dual X- and X-band frequencies, new selenide-isotope power generators, and a drag-free spacecraft whose small rocket motors could counteract opposing external forces to keep the craft in correct solar orbit. (*JPL Universe,* May 26/78, 1)

May 29: Av Wk reported that President Carter had signed a policy directive establishing a unified policy for all U.S. military and civilian space programs that would broaden the civilian role in both military and civilian areas. Civilian space programs had not previously benefited from military R&D because of security restrictions; the new policy would reduce restrictions on technology transfer from the military to the civilian sector. Civilian space projects and users of civilian space technology (such as the Dept. of Agriculture) that had not had access to data from military programs (such as imagery from U.S. photoreconnaissance spacecraft) would be able to use in the civilian sector data gathered by military spacecraft. Space programs on weather and climate, land use, and earth resources could now use military data where applicable.

The directive had named presidential science adviser Frank Press to head a U.S. space program coordinating committee of users and suppliers of space data. The committee would oversee development and coordination of both military and civilian programs. The policy also attempted to identify and reduce stresses among the four major U.S. space programs: intelligence-community programs using spacecraft such as Lockheed's "Big Bird" high-resolution reconnaissance satellite; DOD space programs using spacecraft such as the defense satellite communications system (Dscs) vehicles; civilian/government space programs using vehicles such as those flown by NASA and NOAA; and civilian/private-program spacecraft users such as commercial communications-satellite operators, and possibly future commercial remote-sensing companies. (*AvWk*, May 29/78, 23)

• *Av Wk* reported that the Soviet Union had launched its 15th killer-satellite test since 1968, less than a mo before the scheduled start of anti-satellite-limitation talks with the U.S. The USSR had launched on May 19 an interceptor, *Cosmos 1009*, toward a target, *Cosmos 967*, launched Dec. 13, 1977, which had also been target for the USSR's 14th unsuccessful killer-satellite test Dec. 21, 1977. (*AvWk*, May 29/78, 23)

May 30-June 1: NASA launched *Pioneer Venus 1* from Cape Canaveral at 9:13am EDT May 20 atop an Atlas Centaur rocket. It would launch a Venus lander toward the planet 3mo later, about Aug. 7. *Pioneer Venus 1*, an orbiter, should reach its destination by Dec. 7, 1978; *Pioneer Venus 2*, a multiprobe spacecraft, would arrive 5days later after splitting into a bus and 4 atmospheric-entry probes 13 million km (8 million miles) and 20days out from the planet. Most engineering systems and the interplanetary experiments had signaled normal operation. "Performance so far has been extremely good," said Marshall Johnson, Venus-orbiter flight director at ARC. "Of course, we have 300 million miles and 6mo to go," he added. At 9am PDT June 1 the spacecraft was 4 800 000km (2 890 000mi) from earth and had traveled toward Venus at 16 580kph (10 296mph). Controllers would make the first midcourse correction June 8, changing velocity to 12.6kph (7.8mph) to aim the Pioneer at the exact point for Venus orbit insertion.

Pioneer Venus 1, a spin-stabilized spacecraft with its spin axis perpendicular to the ecliptic plane, consisted of a cylindrical thrust tube serving to transmit acceleration loads into the spacecraft; a 97.5in-diameter circular equipment shelf for mounting electronic units and scientific instruments; a 100in-diameter cylindrical substrate 48in long for mounting the solar-cell array; and a despun mast assembly supporting three antennas, including a high-gain antenna. A single-piece fitting that would remain on the Centaur at spacecraft separation would be the mechanical/structural interface with the launch vehicle. Payload was 12 scientific instruments with a total weight of 100lb, using average power of 58watts and peak power of 85watts. The instruments could handle 75 redundant discrete commands and 6 redundant quantitative commands, as well as 17 serial-digital, 24 bilevel, and 31 analog telemetry channels. Three of the instruments would use pyrotechnic firing pulses for various functions. The magnetometer had been put at the tip of a 15.7ft beam to isolate it from spacecraft magnetic fields. The *Pioneer Venus 1* launch vehicle was an Atlas SLV-3D Centaur D-14 131ft tall, weighing about 328 640lb at liftoff. The nosecover protecting the spacecraft, a conical/cylindrical fiberglass fairing about 29ft high attached to a 56in-high aluminum split barrel, had been designed for jettison early in the Centaur burn.

NASA had launched *Pioneer Venus 1* into an ascent trajectory varying from 3° to 18° south of due east during the first 15days; the 7mo flight to Venus would take the spacecraft more than halfway around the sun (through about 200°), covering about 480 million km (300 million mi). The orbiter would take 3mo longer for the trip than the multiprobe, and would have a slower speed upon arrival at Venus, requiring less power from the orbit-insertion motor. For the first 82 days after launch, *Pioneer Venus 1* would fly outside the earth's orbit. In Aug. it would return inside earth's orbit and, during the last 4mo of the journey, would cross 42 million km (26 million mi) on a long curving trajectory between the orbits of the earth and Venus. The orbiter's flight path would resemble that of the Venus multiprobe, to be launched a few days after the orbiter crossed back inside earth's orbit.

NASA had designed the flights to answer questions such as: Why had two planets with about the same mass, formed of similar materials and situated at comparable distances from the sun, evolved different atmospheres? Why had the surface of Venus baked in searing heat, while earth had climate friendly to life? Answers would aid in understanding the evolution of Venus and earth atmospheres and the forces affecting earth's weather. The Pioneer Venus flights, first devoted to studying another planet's atmosphere and weather on a global scale, would use the largest number of vehicles devoted to such studies and would make measurements at the greatest number of locations. The flights would record characteristics of Venus's upper atmosphere and ionosphere, as well as of the lower atmosphere, and interactions of these regions with the solar wind (the continuous stream of ions and electrons flowing outward from the sun) and with the solar magnetic and electric fields. Circling the planet for at least 80mo, the Pioneer Venus orbiter would make the longest observations of Venus to date and would be the first U.S. spacecraft to orbit the planet.

A NASA-contractor team under KSC's expendable vehicles directorate had been responsible for preparing and launching *Pioneer Venus I*. Hughes Aircraft Co. had built the spacecraft and radar mapper. (Ames Release 78-21; MOR S-825-78-01 [prelaunch] May 15/78; [prelaunch summary] May 11/78; NASA Release 78-68; NASA press brief May 9/78; *Marshall Star*, May 17/78, 1; May 24/78, 1; *Lewis News*, May 26/78, 1; *JSC Roundup*. May 26/78, 1; *DFRC X-Press*, May 19/78, 2; *C Trib*, May 21/78, 1-3; *W Post*, May 21/78, A6; *NYT*, May 22/78, A10; *W Star*, May 21/78, A-2)

May 31: MSFC reported that 17 scientists had signed contracts to develop materials-processing experiments, first to be conducted in the weightless environment of the Space Shuttle and Spacelab and partially based on results of investigations during the Apollo, Skylab, Apollo-Soyuz, and SPAR (space processing applications rocket) programs. Among the products of interest to the scientists were improved medicines; electrolyte materials for smaller, higher capacity batteries; and larger, more perfect crystals for electronic applications. The $12 million program, covering a 5yr initial period, should produce significant scientific results for developing specific useful materials and products in space. NASA had aimed the programs at science and technology in both research and manufacturing activities leading to privately funded materials-processing in space.

Five of the 17 scientists would have a chance to fly their experiments on an early orbital test of the Shuttle in a materials-experiments assembly (MEA) package that would not only produce valuable scientific data but would also define further experiments and hardware needed before the first extended flight on Spacelab or Space Shuttle. A Shuttle satellite-deployment mission would fly four of the MEA experiments again, along with five others; the fifth would fly again on the third Spacelab mission devoted almost exclusively to materials processing. Four more of the scientists would have experiments on this mission. (*Marshall Star,* May 31/78, 1)

• NASA reported it had amended a contract with Rocketdyne Division of Rockwell Intl. Corp. to procure 9 Space Shuttle main engines, in addition to the 7 already on order. The amendment had authorized Rocketdyne to manufacture and test the 9 engines during a 180-day period in which prices would be negotiated. Estimated cost of the amendment had been $250 million. The 9 engines would support the Space Shuttle program through the first 4 orbiters approved for production; the present contract had covered engines for the first Space Shuttle flight scheduled for 1979 and had included 3 ground-test engines and 1 spare. (*Marshall Star*, May 31/78, 3)

• MSFC announced it had successfully completed at the National Parachute Range May 23 an airdrop test of the parachute system designed to recover Space Shuttle's reusable solid-fuel rocket boosters after launch. This was the fourth drop test in which a dummy booster had been carried aloft beneath the right wing of a B-52 aircraft; the recovery system's three main parachutes had all deployed, and all had functioned as expected. The dummy booster had landed virtually undamaged. NASA engineers planned two more airdrops before certifying the system for flight. (*Marshall Star*, May 31/78, 2)

During May: The Natl. Aeronautic Assn. announced that a 15-member U.S. aerobatic team would travel in Aug. to Ceske Budejovice, Czechoslovakia, to compete in the ninth World Aerobatic Championships sanctioned by the Intl. Aeronautic Federation (FAI). The 1978 U.S. team would be all male, as no woman had qualified in competitions to determine team members. Three-time U.S. national champion Leo Loudenslager, an American Airlines pilot, said, "We have high expectations. We have even better trained pilots and more sophisticated aircraft than we did in 1976, and we are more knowledgeable about what to expect." The 1976 U.S. team had lost to the USSR the titles it had captured in France in 1972: top team, best male, and best female. Loudenslager would fly his experimental modified version of the 200hp Stephens Akro, the Laser 200. Henry Haigh might fly the modified Pitts Special biplane in which he had competed in 1976, basically the same design flown by the remainder of the team. The five aircraft for the competition, disassembled Aug. 8 at Kennedy Intl. Airport for transport to Frankfort, would be reassembled and flown to Peine near Braunschweig in West Germany for 2wk of intensive practice, then to Budejovice for the competition.

The championship event would mark nearly two decades of U.S. participation in FAI-sanctioned precision aerobatic competitions, first held in 1960 in Czechoslovakia. The event also would commemorate two-thirds of a century since the first recorded aerobatic flight: Lt. Peter Nesterov of the Imperial Russian Air Service was credited with performing in 1913 the first inside loop in a Nieuport monoplane. NAA, the aero club representing the U.S., had sanctioned as the official team representing the U.S. at the world championships the group selected by the Aerobatic Club of America, which would also be the only team competing in Czechoslovakia without government financing. (NAA newsletter, May 78, 1)

- The USAF reported it had begun initial screening of sites in 10 states for the MX intercontinental ballistic-missile system. DOD officials said screening would identify and evaluate potential MX deployment sites in the continental U.S; the USAF would not make a selection, but rather evaluate candidate sites that could serve MX needs. Initial screening earlier in 1978 had identified 12 geologically suitable sites in 15 states; current studies would focus on Arizona, California, Colorado, Kansas, Nebraska, Nevada, New Mexico, Oklahoma, Texas, and Utah. Final decision would require many additional studies, including environmental impact analyses. Deployment of an MX system could begin several yr after completion of its design and evaluation of environmental impacts. DOD officials had not decided whether to recommend ultimate deployment of the MX, which would depend on the outcome of development and analyses now under way and on approval by Congress. (AFSC *Newsreview*, May 78, 4)

- Aerospace engineers at AEDC reported they had precisely measured damage from a single particle of rain, snow, or dust—or one from a meteorite—striking the surface of a missile or spacecraft at speeds up to 7000mph. Materials better able to protect missiles or spacecraft would result from this research and testing. The precision measurement used a 2-stage launch "gun" to propel small projectiles (3.2in long, 1.625in diameter) through a track formed by four guide rails inside the range's sealed tank, to simulate altitudes up to 46 000ft. The projectile, tipped with a sample of nosecone material, passed through the track and was photographed as it collided with single particles of water, glass, or nylon.

Previous tests had sent projectiles into clouds of small particles; however, engineers had arranged the single-particle impacts to get a more precise understanding of nosecone erosion and its effect on the accuracy of missile and spacecraft trajectories. Uneven or excessive erosion could cause a missile or spacecraft to miss an intended impact point or landing site. SAMSO had conducted the tests on a track 62ft long and 1.625in in diameter, with a 110ft recovery tube. (AFSC *Newsreview,* May 78, 5)

- The Dayton Air Fair had accelerated efforts to complete construction of a Wright B Flyer replica by the Apr. 30 fair date. Operation Tailwing, organized to ensure completion of the project, had had more than 400 participants in the project during the past 2yr. As plans for the original plane no longer existed, the builders had used measurements of one of the two original remaining Wright B craft, replacing wood with aluminum tubing and steel. Computer studies had verified that propellers turning at 1000rpm with a 210hp motor could maintain the original 17-to-1 power/weight ratio. Modern safety standards had required modification of the airfoil design and gas tank. (NAA newsletter, May 78, 6)

June

June 1: NASA announced it had appointed two U.S. scientists to an international group of five seeking to become payload specialists on the first Spacelab mission scheduled for late 1980. One American and one European would be selected to fly on the laboratory to operate the science instruments. The investigators, working group (IWG), composed of scientists representing all investigators, had selected Dr. Michael Lampton of Berkeley, Calif., space physicist at the Univ. of Calif., and Byron Lichtenberg of Natrick, Mass., vestibular researcher at the Mass. Inst. of Technology. The three payload specialists not chosen to fly would be backup specialists and would particpate in ground-based mission activities at Johnson Space Center.

In a similar screening program, ESA had selected its payload specialists from among thousands of applicants from its member states. The Spacelab 1 mission would investigate stratosphere and upper atmosphere physics, materials processing, space plasma physics, life sciences, astronomy, solar physics, earth observations, and space technology. Marshall Space Flight Center had been responsible for payload-specialists training as part of its overall management responsibility for the Spacelab mission; ESA's Spacelab Payload Integration and Coordination in Europe (SPICE) had managed training in Europe. (NASA Release 78-76; *JSC Roundup,* June 1/78, 4; *DRFC X-Press,* June 1/78, 3)

• ESA announced it had organized a tour of several Mediterranean countries to demonstrate use of data from the Meteosat weather satellite. Tour objectives were to display Meteosat-system capabilities exhibited in the documents or images produced by the spacecraft; and to show potential users (meteorologists and others working on the study and management of earth's natural resources) how to use the system. The system included a secondary data-user's station (SDUS) mounted on a trailer towed by a vehicle containing a 2.5m-diameter receiving antenna and all equipment needed to receive analog signals in the WeFax (weather-facsimile) format. Demonstrations had begun in Cairo and would continue in Athens, Tunis, and Algiers. ESA had planned similar demonstrations in other countries covered by Meteosat. (ESA Release June 1/78)

June 2: Kennedy Space Center announced it had awarded Planning

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Research Corporation (PRC), McLean, Va., a $23 626 661 contract extension for engineering support services. Under the 12-mo cost-plus-fixed-fee extension, PRC would continue through May 19, 1979, its design engineering of Space Shuttle equipment and other tasks for KSC's design-engineering directorate, including design of new and modified ground-support equipment and minor facilities-design support for all KSC programs. The Spaceport and Cape Canaveral in Fla., Vandenberg AFB, and Dryden Flight Research Center had received support under the contract. The extension brought the total contract amount since the original award in May 1974 to $97 306 220. (KSC Release 53-78)

June 5: AvWk reported U.S. avionics manufacturers were sure that a NavStar receiver suitable for general aviation use, with features comparable to those of a VOR omnirange distance-measuring equipment and area-navigation computer, would be available for under $5000 by the late 1980s. AEL, Inc., which had designed a microwave landing receiver that could sell for less than $1500 through normal distribution channels, said the price of a NavStar receiver in 1978 dollars could eventually be as low as $2000. The role of NavStar (DOD's satellite-based navigation system) in civilian aviation would depend on availability of inexpensive receivers at least as accurate as the present VOR/DME navaids. The potential market for civilian NavStar receivers had aroused considerable interest among civil-avionics manufacturers, resulting in Langley Research Center's receiving a number of bids in a recent competition for a technology/design study of a low-cost NavStar receiver. Magnavox Government and Industrial Electronics Co. had won the contract. (*AvWk*, June 5/78, 91)

June 6: Although the U.S. had planned to begin talks with the USSR June 7 on killer-satellite control, the Carter Administration had not clarified its own stance toward antisatellite systems, *The Washington Star* reported. The administration had asked the Soviets what they wanted to consider in the 10 days of Helsinki talks described as exploratory, partly as a guide to its own approach. The Kremlin had greeted coolly an earlier Carter proposal to ban antisatellite weapons, which it had been testing since 1967. As Defense Secretary Harold Brown said in Oct. 1977, the USSR already had missiles that could knock down U.S. reconnaissance satellites. The U.S. had studied killer-satellite possibilities for yr without moving to develop them; when the USSR intensified its testing 2yr ago, U.S. interest increased, and officials opposed entering into an agreement that might hinder U.S. efforts to catch up with the Soviets.

On March 30, 1977, Carter announced that the U.S. and the USSR would establish a study group to "develop an agreement whereby we might forgo the development of a capability of destroying satellite observations vehicles, so that we can have an assured way to watch the Soviets [and] they can have an assured way of watching us from satellites" (the principal means of detecting noncompliance with strategic arms-control limitations). Yet, according to Brown's statement, Oct. 1977 was already too late for both sides to give up killer-satellite development. The Navy had been interested in killer-satellite capability because the USSR had begun to use ocean-surveillance satellites to locate American ships. The USSR had also tried to use satellites to detect submerged submarines, making missile-carrying submarines vulnerable and offering a threat to the undersea leg of the U.S. triad of nuclear deterrence. (*W Star,* June 6/78, A-4)

- The British Interplanetary Society's journal *Spaceflight* reported that NASA had developed a lunar- and planetary-sciences teaching aid, using actual samples of lunar material encased in a clear plastic disk, to educate both the earth-science student through the Aerospace Education Program and the museum visitor through the NASA exhibits program. The hand-held aid would permit looking at, or viewing through a microscope, both sides of a sample. Under an 8yr program for lunar- and planetary-science education, colleges had been able to borrow thin-section microscope slides of lunar material along with a teaching manual, and museums and fairs could display several dozen prepared lunar samples in cases. But until now, NASA had directed no program toward the secondary school earth-science student.

The new school-use program which included a film on lunar science, the sample disk, workbook material, slides, and an audio cassette) would require considerable interaction between teacher and class. Student reaction to the museum program, which included a shorter sound-slide presentation and the disk, had been highly favorable. NASA expected to test museum-visitor reaction later in 1978 and to use about 2/3lb of lunar materials to make 100 lunar-sample disks available for use in both programs. Apollo astronauts had brought back 843.5lb of lunar material during lunar explorations in the late 1960s and early 1970s. (*Sf,* June 6/78, 218)

- In recognition of the energy shortage and the need to conserve fuel, the Natl. Aeronautic Association announced it had established a new national aviation-record category for competition among U.S. airlines, Efficiency on a Commercial Air Route. NAA had administered for a number of yr the category Speed on a Commercial Air Route, which had proved popular with airlines and airline pilots. This category would continue, in conjunction with the new category, to measure efficiency over a route by the amount of fuel used according to the mileage and number of passengers carried. The measurement would result in an efficiency-index number, and the highest number over a given route would hold that particular record. To maintain equity, five categories had been based on maximum gross aircraft weight, and one open category would include all aircraft. (NAA newsletter, June 6/78)

• *Spaceflight* reported that British aerospace engineers had completed a study that might lead to construction in space of a huge power station capable of generating an electrical output equal to 5 to 10 power stations on earth. Britain's BAe Dynamics Group, the European company most experienced in assembling space-solar arrays, had done a 6mo study under ESA contract of solar arrays to provide extra power for the European Spacelab and space platforms, as well as for a space power station. A pilot-unit space platform designed to operate in a low-earth or geostationary orbit would supply 1 to 2megawatts, as precursor of a power station in geostationary orbit with a power output of 5 to 10 gigawatts (5000 to 10 000megawatts). Europe had already demonstrated it was capable of significant contributions to large space power-plant technological development. (*Sf*, June 6/78, 219)

June 7: The *Marshall Star* announced it had begun ground-vibration tests of the Space Shuttle, using a computerized shaker system turned on by engineers in instrumentation trailers located near the test stand. The shaker system, the Shuttle modal test and analysis system (SMTAAS), had applied vibration cycles and force inputs and had acquired response information from the vehicle suspended inside a tall stand and canted 9° from vertical. In upcoming months engineers would use SMTAAS to "tune in" to the vehicle's various vibration modes, comparing responses to mathematical predictions. Results of the tests would allow engineers to verify predictions of Shuttle reaction to the much more severe vibrations expected during launch. (*Marshall Star*, June 7/78, 1; *JSC Roundup,* June 9/78, 1; *DFRC X-Press,* June 16/78, 2; *AvWk,* June 19/78, 75)

• MSFC announced plans to begin thermal-vacuum testing of NASA's second high-energy astronomy observatory, HEAO-B, as part of a series of environmental tests on the satellite before scheduled launch in Nov. TRW Systems, Inc., HEAO prime contractor, would conduct the 2wk-long test to simulate thermal-vacuum conditions in space. HEAO-B had already undergone a number of environmental tests, including acoustic and mechanical vibration tests. (*Marshall Star*, June 7/78, 1)

• A House subcommittee on space science and applications would hold panel discussions later in June on opportunities for international cooperation in space, the U.S. House Committee on Science and Technology announced. Moderated by Dr. Jerry Grey of the American

Inst. of Aeronautics and Astronautics, the discussions would follow subcommittee hearings scheduled May 16, 17, and 18 on international space programs. Panelists reviewing the hearings would make recommendations on international cooperation for publication with the hearings. Rep. Don Fuqua (D-Fla), subcommittee chairman, said he favored use of the space environment "not only for our own nation but for the benefit of all mankind. All reasonable efforts should be made in the international community to assure that worldwide understanding and mutual commitments are developed to provide sound basis for these future efforts." (U.S. House Committee on Sci and Tech Release, June 7/78)

June 9: NASA Deputy Administrator Dr. Alan Lovelace, addressing members of LeRC's launch directorate, had termed the launch-vehicle team "probably the best in the world. The record speaks for itself," the *Lewis News* reported. Lovelace had visited LeRC to discuss the role of launch vehicles in NASA's overall plans and to be briefed on other Lewis work.The expendable vehicles would make 13 launches through 1980, when the Space Transportation System (STS) would begin carrying payloads into space. Members of the STS team responsible for launching the Space Shuttle who would work with the LeRC launch-vehicle group "can learn team development, discipline, and mental rigor from the exemplary record of the Lewis team,'' Lovelace said. (*Lewis News,* June 9/78, 1)

• In its "Profile of a Mission," *Lewis News* reported that a new era of opportunity in space had become available. The Space Transportation System (the Space Shuttle) would open the door to activities ranging from experiments in basic research on physical and chemical process, to using the weightlessness and vacuum of space as an environment for manufacturing products. LeRC's Space Experiments Integration Office (SEIO) would help principal investigators proposing experiments that needed a space environment, by preventing duplication of effort and standardizing paperwork required for project approval.

SEIO had management responsibility for one facility and four experiments, three of which were to fly on the long-duration exposure facility (LDEF) managed at LaRC:

—The advanced photovoltaic experiment (APEX) on the LDEF consisted of three related approaches to investigating the solar spectrum and the effect of exposure to space on advanced photovoltaics and materials. For the first time, space-calibrated solar cells would be available as laboratory standards for assessing performance of new solar cells.

—The space power experiment (SPEX) on the LDEF would evaluate the use of commercially available components for a space-power system. With three LDEF trays carrying commercially available terrestrial solar cells and a fourth carrying commercial power electronics and batteries, successful operation of these components in space could significantly reduce costs of future space-power systems.

—In the ion-beam texturing and surface-coating experiment on the LDEF, which would expose such surface samples to launch stress and near-earth space, ground tests before and after exposure would record the optical properties of the surface of each sample and compare durability of ion-beam-textured surfaces with that of state-of-the-art surfaces. If the ion-beam-textured surfaces exhibited higher durability, use of thermal-control coatings for spacecraft would increase.

—The cryogenic fluid-management experiment (CFME), a payload attached to a Spacelab pallet, would obtain long-duration low-gravity engineering data on systems for storage/acquisition/supply of liquified gas (subcritical) to verify the possibility of successfully operating such a system in space.

The zero-gravity combustion facility (OGCF), a versatile reusable assembly that would permit a Spacelab experimenter to study combustion free of earth's buoyancy forces, would carry out tests ranging from rapid burning to long-term smoldering of a variety of liquid, solid, and gaseous fuels. (*Lewis News,* June 9/78, 3)

June 11: The *Washington Post* reported that the USAF had launched on June 10 from Cape Canaveral a Titan 3C rocket carrying a classified satellite cargo under unusually tight security; the rocket had operated in a normal Titan flight pattern. A USAF statement said only that a USAF industry team had participated, but not whether or not the launch had been successful. The *Post* said the security measures—with guard dogs and USAF combat personnel supplementing the usual guard force—had been heavier than for any previous launch at the Cape. Workers at the launch pad did not know what the payload was, and received passes only to the specific areas of their assigned duties. A Titan 3C, which could lift up to 10tons into space, had been used several times to launch military-intelligence satellites; it could also lift a series of satellites and drop each in various orbits. The most recent classified launch from the Cape had been on April 6, making this the shortest interval between classified missions in more than 11yr. (*W Post,* June 11/78, A9)

June 12: Av Wk reported that engineers suspected a hot-gas system leak in the sustainer engine of the USAF/General Dynamics Atlas F launch vehicle as the cause of overtemperatures registered during recent DOD NavStar launches from Vandenberg AFB. Overtemperatures in the boattail area of the Atlas F (recorded in telemetry from the launches of *NavStar 1* in Feb. and *NavStar 2* in May) had forced postponement for at least 14days of SeaSat-A's launch from Vandenberg. Rockwell Intl.'s Rocketdyne Div. had test-fired the engine to determine whether a leak in the sustainer engine's hot gas system was responsible, and to pinpoint the location of the leak. They also had hot-fired sustainer-engine gas generators as part of the investigation. General Dynamics had monitored aerodynamic flow around the Atlas F during flight for hot gas from the exhaust plume impinging on the boattail.

Temperatures in the boattail had climbed earlier than expected during the NavStar launches; in one launch, that area had become hot enough to melt insulation on copper wires, causing failure of some onboard instruments and intermittent operation of others. NASA had increased insulation on some wire bundles in SeaSat-A's Atlas F; more insulation around other rocket's components might also be added. Additional instruments installed in the launch vehicle should obtain more details on temperature and pressure conditions in the boattail area during launch, program officials noted. They had not decided whether to postpone launch of the third NavStar satellite, planned for Aug. (*AvWk*, June 12/78, 18)

- *Av Wk* reported MSFC's intent to demonstrate within 5yr the assembly of a large space structure in low-earth orbit, to exploit Space Shuttle capability. MSFC had proposed assembling a 10 × 30m (33 × 98ft) structure in space to demonstrate fabrication and assembly techniques, followed closely by a Space Shuttle mission to demonstrate deployment of a large antenna 50 to 200m (164 to 656ft) in diameter. The USAF Space and Missile System Organization (SAMSO) had also expressed interest in flying a Shuttle-based antenna-deployment test before 1985.

Although most U.S. aerospace companies had been working on structures in space, Grumman Aerospace Corp. had been in the forefront in large space-structures work; MSFC had awarded Grumman four of six contracts for large space structures development, and JSC had awarded it at least one significant contract. MSFC's approach had been to define tools and procedures needed, and to evaluate whether such operations would be possible and to what degree. Most building-block study for large space structures had assumed the use of open-truss aluminum beams joined by diagonal and cross braces, with beam sections 1m (3.2ft) wide and length varying according to mission. Grumman had just begun to demonstrate a beam-building machine [see Apr. 12]. Both NASA and Grumman had been scheduled to evaluate the beams for deviations from specifications such as straightness or basic strength, and for individual subsystems such as the automatic welders used to affix the cross sections. In Sept. Grumman would transfer the beam-builder to MSFC for tests of beam manufacturing in a vacuum, to simulate space conditions. (*AvWk*, June 12/78, 49)

June 13: NASA announced it had appointed Robert Allnutt associate deputy administrator. Allnutt, currently acting assistant general counsel for legislation at DOE, had been deputy assistant administrator for the Energy Research and Development Administration, responsible for program areas including procurement, personnel, labor relations, and construction. Following a career both inside and outside the executive branch, Allnutt in 1970 had been appointed associate general counsel to the congressionally-established Commission on Government Procurement to improve governmentwide policies, procedures, and legislation. In 1973 Allnutt had been appointed staff director and counsel of the Senate Committee on Aeronautical and Space Sciences, with jurisdiction over federal aerospace research and development activities including all NASA programs.

NASA had named Isaac Gillam, IV, director of DFRC, where he had been acting director since the departure of David Scott in Nov. 1977; he had been deputy director there since Aug. 1977. Gillam, an associate fellow of the American Inst. of Aeronautics and Astronautics and a senior member of the American Astronautical Society, had joined NASA Hq in 1963 as a resource-management specialist and had gone to DFRC in 1976 as director of Space Shuttle operations. Before joining NASA, Gillam had served in the USAF.

Lt. Gen. Duward Crow (USAF-ret.), assistant to the deputy administrator of NASA, had announced plans to leave NASA Sept. 1, 1978. Gen. Crow had begun NASA service in 1974 as assistant administrator for DOD and interagency affairs. In Oct. 1975 he had become associate deputy administrator of NASA, assuming his present duties following a reorganization in Nov. 1977. Crow had graduated in 1941 from the U.S. Military Academy and had served in the China-Burma-India theatre of operations. He had become comptroller of the USAF in 1969 and was assistant vice chief of staff from Oct. 1973 to July 1974 when he retired. He had received NASA's Distinguished Service Medal for his work on the NASA launch vehicles program. (NASA anno June 13/78)

- KSC announced it had awarded Management Services, Inc., Huntsville, Ala. a $1 774 404 contract extension to operate the Spaceport's component-refurbishment and chemical-analysis laboratories. The 1-yr extension, a cost-plus-award-fee contract set-aside for small business, had brought the total value of the original contract to $4 536 339. The basic contract, awarded in 1976 for 3yr with annual renewals, had been negotiated competitively. (KSC Release 58-78)

June 14: NASA announced plans to launch Comstar-C on an Atlas Centaur launch vehicle for Comsat General, a subsidiary of ComSatCorp, on a fully reimbursable basis. NASA had successfully launched *Comstar 1A* and *Comstar B* on May 13 and July 22, 1976, respectively; a fourth satellite being built would serve as a spare. KSC and its Expendable Vehicles Directorate would be responsible for preparing and launching the Atlas Centaur vehicles; a joint government-industry team would supervise all launch-vehicle and pad operations during countdown. The ETR, launch-vehicle contractor General Dynamics, and NASA would supply all personnel and equipment required to handle assembly, prelaunch checkout, and launch.

The Comstar spacecrafts used by American Telephone and Telegraph Co. as part of its nationwide communications network had a capacity of more than 14 000 high-quality 2-way voice circuits. In geostationary orbit at 22 300mi altitude, they could provide reliable communications to the 48 contiguous states, Alaska, Hawaii, and Puerto Rico. Each Comstar carried centimeter-wave beacons to test higher frequency propagation at 19 and 28GHz, measuring the adverse effects of rainfall on signals at these frequencies, and leading to possible use of higher frequencies to future commercial comsat systems. Under an agreement with Comsat General, AT&T would lease the entire capacity of the three in-orbit Comstars; AT&T, which was building its own earth-station network, would integrate satellite communications with its terrestrial facilities to enhance its domestic U.S. services. (MOR M-491-201-78-01 [prelaunch summary] June 14/78; *Spaceport News,* June 23/78, 1)

- MSFC reported that an invention by MSFC engineer Frank Nola to decrease energy consumed by electric motors [see May 2] had aroused the most public interest of any invention by the center. Accounts of the invention in *Chemical and Engineering News* and *Industry Week* drew more than 600 inquiries from readers. An item in *Kiplinger Letter* had produced about 1430 reader responses. George Porter, patent counsel in MSFC's Office of Chief Counsel, said his office had received three applications for licenses to manufacture the power-factor controller. MSFC's Technology Utilization Office also had received almost 300 letters and telephone calls. The invention had been tested in a textile mill in Alexander City, Ala., using 3700 industrial sewing machines operated by half-horsepower 3-phase motors. One of the motors equipped with the power-factor controller had recorded a power saving of 33% over an identical motor without it. (*Marshall Star,* June 14/78, 2)

June 15: NASA announced that its scientists had apparently discovered a way to account for the formation on earth 4 billion yr ago of nucleic acids, one of two essential "building blocks of life." The discovery had followed earlier work by the same investigators (Dr. James Lawless, team leader at Ames Research Center; Dr. Edward Edelson, National Research Council fellow; and Lewis Manring, student at the Univ. of Santa Clara) that revealed a mechanism to explain the formation of the other critical building block, protein. Taken together, the findings answered a years-old question about the chemical evolution of life on earth.

Theorists had wondered how the building blocks of life, randomly scattered on the shores of primitive oceans, could continuously congregate and organize over millions of yr in concentrations high enough to produce living organisms. The explanation was found in substances common on the shores of primitive oceans: metal clays. Dr. Lawless had mixed low-concentration solutions of DNA-forming nucleotides with commonplace metal clays, and found that most clays attracted them. One type of metal clay containing zinc had preferentially attracted all six of the building blocks of DNA and RNA nucleotides. Especially significant was that zinc clay had attracted 97% of the nucleotide 5-prime adenosine monophosphate (AMP), most common DNA building block in living systems and essential precursor to ATP, the basic energy molecule present in every life form. Zinc also had been a constituent of the enzyme DNA polymerase, which linked DNA building blocks (nucleotides) in living cells; enzymes had acted as super catalysts, drastically speeding many life processes.

Dr. Lawless had done another experiment in which zinc clay had preferentially attracted the "5-prime" life-form over the "2-prime" and "3-prime" forms, the 5-prime form being the only one found in living organisms. The result had suggested a mechanism for incorporating this life-specific building block into the first DNA-like material.

Scientists had previously applied electric discharges or other energy release to ammonia, methane, and water vapor to produce small quantities of basic life molecules; however, until Lawless's discovery, they could not explain the behavior of life-building blocks in primordial water. Lawless's group would also try to show metal clays linking nucleotides into polynucleotides, the next step toward forming a DNA-like molecule. (NASA Release 78-85)

June 16: Spacecraft controllers had completed a maneuver to move the planet-arrival point of *Pioneer Venus 1* from the southern hemisphere to an orbital-injection point 216mi above the northern hemisphere, *DFRC X-Press* reported. The course change also had slowed the spacecraft so that it could use the sun's gravity to increase its speed. NASA expected that the flight-path change would allow *Pioneer Venus 1* to enter its planned long-oval orbit tilted 75° to the planet's equator, with the closest approach 180mi from Venus, greatest distance 41 000mi. *Pioneer Venus 1* had been scheduled to reach Venus in Dec. *(DFRC X-Press*, June 16/78, 4; *ARC Astrogram*, June 1/78, 1)

- For 4yr, the LaRC Space Systems Div. and Flight Dynamics and Control Div. had analyzed the Space Shuttle orbiter's entry guidance and control system at the request of JSC, the *Langley Researcher* reported.

The system had been designed to control the orbiter from deorbit until landing, regulating both the aerodynamic surfaces and a reaction control system (RCS) composed of small rocket thrusters such as those on Apollo spacecraft, so that orbiter control had turned out to be a hybrid between aircraft and spacecraft control. Onboard computers could direct the entire orbiter entry without pilot input, or a pilot could take over control if necessary.

A primary tool in the LaRC analysis had been a reentry flight dynamics simulator (RFDS) that permitted evaluation of the onboard-control system in both the automatic and the manual modes. It had also aided in developing alternate control systems to be used by the pilot if the main control system could not handle a situation. The simulator cockpit, though not an exact representation of the orbiter cockpit, did contain all the instruments and controls necessary to simulate flight: cathode-ray tubes (CRTs) showed displays identical to those on board, changing guidance information automatically as the orbiter entered various flight regimes. Push buttons and toggle switches would permit the pilot to take over any of the control functions.

LaRC investigators had found that the system was dangerously sensitive to possible sensed angle-of-attack errors in the automatic mode at hypersonic speed. Shuttle astronaut Col. Henry Hartsfield had been unable to maintain vehicle control in the manual mode. This and other problems had led to major system redesign that had been tested at LaRC and found to solve the sensed angle-of-attack problem. Investigators had then begun work on other system problems. (*Langley Researcher,* June 16/78, 1)

- Under a cooperative agreement between NASA and the U.S. Navy, a Navy experimental plane would undergo in-place tethered-flight testing at LaRC's Impact Dynamics Research Facility, the *Langley Researcher* reported. The Navy's XFV-12A plane built by Rockwell Intl.'s Columbus Aircraft Div. was the only one of its kind, a prototype V/STOL aircraft designed to demonstrate the thrust-augmented wing concept in supersonic flight. The tests at LaRC had tethered the XFV-12A to the gantry by a single cable from a powerful winch mounted 210ft above ground. Static restraint tests kept the aircraft in place at various heights by ground cables attached to the nose and main landing gear, as its engines operated at full power. Using results of the static tests, LaRC had put the XFV-12A through dynamic tests, permitting greater freedom of motion, as the aircraft was not restrained by ground cables. The upper tether cable automatically reeled in as the aircraft maneuvered within the gantry, and a shock absorber on the winch cable guarded the airplane against loads greater than 2g. (*Langley Researcher*, June 16/78, 6)

- ESA announced that the full-scale propellant mockup of the European launcher Ariane (47m high, maximum diameter 3.8m) had left the integration site near Paris for its launch base at Kourou in French Guiana on the South American coast. Two Seine barges had transported three pressurized containers (one for each stage) to Le Havre, where they were loaded on a freighter bound for Cayenne. Tests of the mockup would begin in Aug. when the launcher would be erected on the pad for the first time.

ESA had planned 3mo of tests to check general conditions for launcher assembly and vehicle compatibility with ground facilities, as well as fueling and draining facilities and systems both on the ground and on the vehicle. Centre National d'Études Spatiales (CNES) would handle transport, assembly, and test operations. Aerospatiale, the system integrator, would evaluate dynamic and thermal behavior of the launcher under ambient climatic conditions in tests simulating vibrations like those at liftoff. ESA had planned four qualification launches between June 1979 and Oct. 1980 (ESA Release June 16/78)

June 19: As the climax of a 4-mo attempt to stabilize and trim the orbital position of Skylab, a NASA team of engineers and controllers from JSC, MSFC, IBM, and three tracking stations (Bermuda; Madrid; and Goldstone, Calif.) had successfully put the space station in an orbital position they hoped would prolong its lifetime in space, JSC announced. Maneuvers in June had put the space station in an attitude intended to reduce atmospheric drag at its orbital height of 389km (242 statute mi). Assuming that the gyros continued to function, NASA hoped the new attitude would extend the orbital lifetime of Skylab by 6 to 12mo to late 1979 or early 1980, giving NASA time to arrange an early Space Shuttle test flight to reboost Skylab into higher orbit, or deorbit it into a remote ocean area.

Maneuvers had begun in Mar. when engineers and flight controllers at the Bermuda tracking station checked out Skylab systems and brought its batteries to a fully charged state. On June 8, flight controllers had turned on the dormant control-moment gyros in the Skylab attitude-control system. (The other part of the system, the thruster attitude-control system, would expel nitrogen gas through nozzles to move Skylab into various attitudes in its orbit.) A computer with various sensors to indicate position had controlled both systems. Although one gyro that failed during the last Skylab mission in 1974 could not be used, the other two gyros were activated and worked as expected.

On June 9, controllers had commanded Skylab into a solar inertial attitude in which the spacecraft's solar cells always faced the sun. On June 11, they had maneuvered it into the desired "end-on velocity-vector" attitude, docking port forward and long axis parallel to the ground along the flight path. Skylab had remained in that position while engineers continued to monitor it, periodically transmitting minor corrections to the onboard computer controlling Skylab's position. (JSC Release 78-25; *Marshall Star*, June 7/78, 1; June 14/78, 1; *JSC Roundup*, June 9/78, 1; June 23/78, 1; *DFRC X-Press*, June 2/78, 2; June 30/78, 2; *W Post*, June 12/78, A-19))

• MSFC had designed a geostationary-orbit platform that could perform the functions of more than a dozen domestic communications and weather satellites serving North America, *AvWk* reported. As early as 1986, NASA could use the Space Shuttle to assemble the platform, first U.S. large space structure in synchronous orbit. NASA would assemble the platform over the course of three Space Shuttle missions, using technology under design at MSFC and JSC. Analysis had predicted that over a platform's 15-yr lifetime it could save 50% of the cost of operating communications and weather systems now scheduled to be placed in synchronous orbit during that period.

Institutional rather than technical barriers had delayed completion of the platform project, but MSFC had reached agreement among common carriers and hardware manufacturers on the savings possible by using the platform. One concern of NASA planners was that grouping communications systems on a single platform would make them more vulnerable to Soviet attack; however, MSFC planned to issue an RFP of about $500 000 for major systems studies in FY79 and FY80 that would constitute Phase A evaluation of typical platform requirements; phase B would require about $1 million for FY80 and FY81 for system design concepts. (*AvWk*, June 19/78, 67)

June 21: Preliminary results from a 6-yr experiment at the San Andreas fault in Calif. indicated that earth motion along the fault had accumulated at a rate much faster than expected, equivalent to 6 to 7m over the past 70yr, *Goddard News* reported. Measurements from tracking sites on both sides of the fault in the San Andreas Fault Experiment (SAFE) to determine gross plate motion across the fault, and to demonstrate practical application of satellites and ground-based lasers in tracking relative motion of the earth's upper plates, had produced satellite tracking data accurate within a few centimeters. Gross motion across the fault had provided a measure of strain energy as it accumulated, eventually to be released as an earthquake. Goddard Spaceflight Center's pulsed laser ranging systems had measured earth motion by determining the range to a satellite, measuring the time required for a short pulse of intense light to travel from the laser to the satellite and back, and repeating the measurements once per second throughout each satellite pass. GSFC had performed the SAFE experiment in cooperation with a broad cross section of the scientific community. (*Goddard News*, June 21/78, 1)

• GSFC announced that, in a cooperative program with NOAA, its scientists had demonstrated the benefits of using short-interval full-resolution satellite images to monitor tropical cyclones. The agencies had undertaken the program to determine optimum resolution and image frequency for selecting winds to study, in forecasting tropical-cyclone intensity. Experiments using the *Sms 2* to study hurricane Eloise and cyclone Caroline, and *Goes 1* for tropical storms Belle and Holly, had taken scan images of the storms at varying resolutions and at a variety of time intervals. GSFC using its atmospheric and oceanographic information processing system (AOIPS) to examine the experimental data, had found that rapid-scan full-resolution visible images could best disclose the wind vectors. Scans taken every half or quarter hr had been inadequate, because many clouds of the type and size best suited for tracking did not persist or maintain their shape for as long as 30min. GSFC scientists also had found that the full-resolution visible images could improve cirrus tracking and could increase the number of trackable elements available from coarser-resolution infrared images. (*Goddard News,* June 21/78, 4)

• MSFC reported that the American Inst. of Aeronautics and Astronautics had selected William Rice, deputy manager of Space Shuttle solid-fuel rockets at MSFC, to receive the Wyld propulsion award for "outstanding contributions to development of solid propellant rocket motors and superior leadership of aerospace technology programs." AIAA had presented the award each year to reward work in development or application of rocket-propulsion systems. Rice would receive a medal and certificate at an awards luncheon during the AIAA/SAE Joint Propulsion Conference. (*Marshall Star,* June 21/78, 1)

June 22: Nature magazine reported that NASA planned to draw more academic scientists into its R&D activities. NASA Administrator Robert Frosch had issued a policy statement that, in the future, academic scientists would conduct "a substantial proportion" of basic research in all agency disciplines. Non-NASA scientists would take a greater part in all NASA basic research, from conception and planning through programming and execution to interpretation of data and publication of research results. The statement said NASA would increase peer evaluation of research projects in order to guarantee high quality. NASA critics had charged that agency research, particularly in areas such as space applications, traditionally proceeded in-house with little outside evaluation.

The new policy, partly in response to President Carter's directive on increased government support of basic science, had aimed at counteracting the criticisms. After NASA's divisions had prepared a list of proposed activities, NASA would publish a 5-yr plan based on these proposals and conforming to the new policy. The Office of Space and Terrestrial Applications, for instance, whose programs at the outset had been essentially technical exercises to test and develop means of data acquisition, had realized its concern with science relatively late, so that scientists had had to do the best they could with the data available. Under the new system, NASA would ensure better working arrangements between scientists and instrument designers in deciding on the most useful data a satellite could collect, from both a scientific and a technical point of view. NASA stressed that greater use of academic scientists would improve quality control at the same time it would help to develop specific fields of scientific knowledge. (*Nature,* June 22/78, 586)

- ESA announced plans to launch its scientific satellite Geos-2 in mid-July from ETR/Cape Canaveral on a Delta. This satellite would carry out the mission originally planned for *Geos 1,* which a malfunctioning Delta injected into a transfer orbit too low to permit attaining its scheduled geostationary orbit. The European Space Operations Centre (ESOC) at Darmstadt, W. Germany, had fired *Geos 1*'s apogee boost motor to inject it into a 12-hr elliptic orbit; after a yr in this orbit, results showed *Geos 1* had made a significant contribution to the International Magnetospheric Study (IMS).

Main mission objective of Geos-2 would be to learn more about responses of the near-earth environment to processes occurring in outer space. The satellite's geostationary orbit would be in a region of earth's magnetosphere where many dynamic processes causing magnetic and ionospheric disturbances were believed to develop. Geos-2's exceptionally high real-time transmission rate (over 100kilobits per sec), combined with a continuous link with ESA's Odenwald ground station in Germany, would allow it to transmit about 100 times as much data as any previous European scientific satellite. Built as a qualification model at the same time as *Geos 1,* the spacecraft had been converted into a high-quality flight model. Based on *Geos 1* experience, only minor modifications were made in some Geos-2 subsystems. Geos-2's very sensitive experiment payload had put severe constraints on spacecraft design in the areas of electromagnetic and chemical cleanliness: for example, a complex system of 8 booms deploying in orbit had to be designed to put the sensitive experiment detectors measuring minute variations in the magnetosphere as far as possible from any electrical interference generated by the satellite. Prime contractor for Geos-2 was British Aerospace Dynamics Group, under the direction of industries in 10 European countries. (ESA Release, June 22/78; ESA Newsletter, June 78, 4)

June 23: NASA declared the launch from Cape Kennedy at 6:36pm Mar. 31 of *Intelsat IVA F-6,* last of the Intelsat IVA series, to be successful. NASA had launched the satellite on an Atlas Centaur into the desired transfer orbit, thus meeting all objectives. Orbital parameters had been 35 912km apogee, 548.8km perigee, 21.84° inclination. ComSatCorp had fired the apogee kick motor Apr. 1 to place the satellite in a near-geosynchronous orbit that would take it at mid-June to its final location at 63°E over the Indian Ocean. (MOR E-491-633-78-06 [postlaunch], June 23/78)

• NASA announced that the USAF Space and Missile Test Command at Vandenberg AFB would launch SeaSat-A on a modified Atlas-F booster no earlier than June 26. Anthony Calio, associate administrator for space and terrestrial applications, noted that NASA had established a launch date of May 17, 1978, early in the program, and had maintained it even when a resolicitation of bids became necessary because of adding a sensor to the original complement. The launch date had slipped from May 17 to June 10 because of a late start of thermal-vacuum testing, and subsequent replacement of a cracked alumina substrate in the power amplifier of the data link. The launch date had then slipped to June 24, then to June 26, because of Atlas-F booster problems [see June 12]. The USAF had grounded the entire Atlas-F fleet for analysis and testing, but this had not delayed NASA's schedule, as rework had continued while the vehicle remained on the stand. (MOR E-655-78-01 [prelauch] June 23/78; *Spaceport News,* June 23/78, 1; *Lewis News,* June 23/78, 1; *Marshall Star,* June 21/78, 1; *Langley Researcher,* June 30/78, 1; *DFRC X-Press,* June 16/78, 3; *JPL Universe,* June 23/78, 1; *Nature,* June 22/78, 586)

• JSC researchers confirmed that a meteorite found by Dr. William Cassidy last winter on an expedition sponsored by NSF to the Antarctic [see Feb. 17] had proved to be one of the rarest types ever seen. A team of JSC meteorite experts using a binocular microscope had examined the fragment inside a lunar-type glove box flushed with dry nitrogen gas, and had sent an 0.4-gram sample to Dr. Brian Mason at the Smithsonian Institution for petrographic analysis of thin sections.

The fragment, 4.5 to 4.6 billion yr old, had been a Type II carbonaceous chondrite (so called because of its high carbon content) of which only 15 other samples had been found, though not in so clean a condition or so well-preserved. These chondrites had been shown to contain amino acids of nonterrestrial origin, suggesting chemical formation of complex organic molecules in other regions of the solar system. The fragment would next be characterized, sectioned, and fully documented; subsequent analysis would then continue. (JSC Release 78-26; *JSC Roundup,* June 9/78, 1; June 23/78, 1)

• Jet Propulsion Laboratory announced its engineers had delivered the first hardware—a thermal-model tape recorder—for the earth-orbiting infrared astronomical satellite IRAS to their counterparts in the Netherlands for testing, before delivering the actual flight recorder in

1979 for installation in the IRAS satellite. A joint program by the U.S., the United Kingdom, and the Netherlands, IRAS had been scheduled for launch from Vandenberg AFB in Feb. 1981, carrying a single experiment: a liquid-helium-cooled telescope to map the sky in infrared frequencies from 1 to 100microns. Infrared astronomers would use the data to construct an infrared sky map and a source catalog with roughly 1 million sources. IRAS would make about 14 orbits of earth daily, but only two daily data-transmitting passes over the U.K. ground station. The tape recorder would therefore store all data for transmission every 12hr. Odetics Corp. of Anaheim, Calif., had built the flight version of the tape recorder for shipment to the Netherlands, where the spacecraft was being built. After completing construction and installation of the telescope, IRAS would return to the U.S. for tests at JPL. (*JPL Universe,* June 23/78, 1)

- LeRC reported that the center's flight operations group had modified a C-131 aircraft for data collection in monitoring earth resources (such as ice thickness on the Great Lakes and heat losses from residential and commercial buildings) by adding an auxiliary power unit, an electrical power-distribution system, special equipment racks, radar antennas, and an inertial-navigation system. Lockheed had constructed special windows and other modifications in the belly of the aircraft to accommodate aerial cameras and an 11-channel multispectral scanner system.

One of the C-131's remote sensing missions had conducted experiments over the Arctic ice ridge in the Beaufort and Bering Seas to see if airborne microwave instruments could obtain ice pressure information. LeRC had also used the aircraft to develop techniques and systems for reporting ice conditions in both fresh- and sea-ice areas for scientific and commercial applications and, cooperatively with EPA, to determine the effects of agricultural practices, strip mining, and land drainage. (*LeRC News,* June 23/78, 3)

- INTELSAT announced it had elected Canadian Marcel Perras chairman of its board of governors and Randolph Payne of Australia vice chairman. Perras, vice president of Teleglobe Canada, had been a member of the INTELSAT board since 1975. Payne, director of marketing for the Overseas Telecommunications Commission of Australia, had represented Australia on the INTELSAT board at various times since its formation in 1973. The board had also reappointed C. J. Steffen of Switzerland and N. Tuckwell of Australia as chairman and vice chairman, respectively, of the advisory committee on planning; and O. Schmeller of the FRG and K. Nosaka of Japan as chairman and vice chairman, respectively, of the advisory committee on technical matters. (INTELSAT Release 78-17-I)

June 26: NASA announced that following the June 16 launch of *Goes 3* on a Delta and successful placement in transfer orbit, it had fired the apogee boost motor at 11:22pm EDT on the same date to produce an orbit with 35 469.1km perigee, 36 679.2km apogee, and 1.7° inclination. The drift had been too rapid, and an orbit-adjust maneuver June 20 had reduced it to 2 deg/day West. *Goes 3* had been scheduled to arrive on station at 135°W July 16, 1978. All subsystems were on, except the visible-infrared spin-scan radiometer (VISSR); the main power bus was normal. The S-band and UHF equipment had functioned properly, but NASA was checking specifics of gain, margin, and sensitivity. Although the space-environment monitor (SEM) subsystem had appeared satisfactory, it needed further testing for possible interference from other subsystems. NASA expected to check out *Goes 3* and turn it over to NOAA for operation when it arrived at 135°W.

Goes 3 would be a key element of the Global Weather Experiment, a worldwide yearlong accumulation of meteorological and oceanographic data that had begun in Dec. 1977. Largest international scientific experiment in history, with 140 nations participating, GWE was collecting information from sources that included nine satellites and scores of ships and aircraft, plus thousands of daily surface and upper-air observations by several hundred buoys distributed in the southern hemisphere and by conventional observation methods elsewhere. The experiment, part of the Global Atmospheric Research Program (GARP) sponsored by the UN's World Meteorological Organization and the Intl. Council of Scientific Unions, would last through 1979 and provide scientists with millions of pieces of information from all over the world. *Goes 3* would not only provide the major western-hemisphere coverage in the experiment, but would also determine how much important meteorological information could be gathered from a data-sparse area of the world centering on the Indian Ocean.

Goes 3 was the last NOAA geostationary satellite NASA would launch on an expendable vehicle; three additional geostationary spacecraft planned for the next 8yr, beginning with GOES-D, would be launched on the Space Shuttle. (NASA Release 78-72; MOR E-612-78-01 [prelaunch summary] Apr 26/78, [postlaunch] June 26/78; NOAA Release 78-66)

- INTELSAT reported that telecasts of the 1978 World Cup soccer championship won by Argentina had been the world's biggest satellite television event. Although final figures had not been tallied, officials estimated the World Cup had surpassed the popularity of the 1976 Montreal Olympics, measured by numbers and hours of international satellite telecasts. INTELSAT said the number of transmissions and receptions of the games had totaled 1364; with an average 2-hr transmission, total time given to transmissions and receptions worldwide was 2728hr. INTELSAT's operations center in Washington, D.C. had estimated an additional 400 transmissions of World Cup material, other than the actual games, accounting for another 700hr. The World Cup thus ran to more than 3400hr compared to the 1976 Olympics, which had held the previous record for satellite television time, more than 2600 transmission/reception hr. (INTELSAT Release 78-18-I)

- General Electric Co. and Comsat General had presented to the convention of the Armed Forces Communications and Electronics Association divergent views on whether DOD should have its own satellite communications systems or should lease service from other organizations, *AvWk* reported. Lee Farnham, vice president of General Electric, said his company, as a hardware manufacturer, would evaluate a number of considerations before entering into any lease arrangement. Joseph O'Conner, vice president for finance and administration of Comsat General, said his firm, as a telecommunications common carrier, had been structured to establish system and lease communications services.

At the insistence of Congress, the Navy had issued an RFP for a Leasat system based on a leasing arrangement. Comsat General might submit two bids, one for a dedicated Navy system and one for a system to serve merchant shipping as well as the Navy. GE's Farnham said a manufacturer would have to consider (in addition to matters such as user requirements and hardware complexity) three factors in making a bid decision: financing, corporate impingement (corporate credit rating), and length of the lease. (*AvWk,* June 26/78, 23)

June 27: NASA declared the *Explorer 52* (Hawkeye) successful over its 4-yr lifetime of investigating particles and fields in the earth's polar magnetosphere out to large radial distances, measuring magnetic-field and plasma distributions in the solar winds, and detecting and measuring with direction-finders the Type III radio emissions from the outer solar corona. Performance of the spacecraft and instruments during the mission had been excellent; the only anomaly (in the optical-aspect system) had been compensated for with the data from the magnetometer system. The spacecraft had reentered the atmosphere Apr. 28, 1978.

Results of *Explorer 52* investigations had included direction-finding measurements showing intense kilometric radio emissions from the earth's magnetosphere, generated at about 1 to 3 earth-radii altitude over the evening auroral zones, with detailed angular distributions of the radiation. Its observations over the South Pole had provided the first information on polarization of these kilometer wave emissions. These data, of special interest to the theoretical space-plasma physics community, had not been explained satisfactorily. Other high-latitude observations had shown an unusual concentration of both electrostatic and electromagnetic plasma-wave turbulence in the 1 to 3 earth-radii altitude range along auroral geomagnetic-field lines, which might be related to generation of terrestrial kilometric radiation. (MOR S-863-74-04 [postlaunch] June 27/78)

• NASA announced it had named Dr. Adrienne Timothy assistant associate administrator for space science, effective June 18. Dr. Timothy would be chief scientist in the Office of Space Science, representing that office to the scientific community as the focal point for obtaining, evaluating, and using its expertise in planning NASA space science programs. She would succeed Dr. S. Ichtiaque Rasool, who had been named chief scientist for NASA's Office of Space and Terrestrial Applications.

Timothy had begun her NASA career in 1974 as staff scientist for solar physics, Physics and Astronomy Programs, in the Office of Space Science. In 1975 she had become chief of the Solar Physics Branch, where she planned and directed U.S. space science research in the solar physics discipline; in 1977 she had become program manager for advanced programs and technology in NASA's Solar Terrestrial Division of the Office of Space Science. Before joining NASA, Timothy had been leader for the Apollo telescope-mount reduction and analysis system at the American Science and Engineering Corp. (NASA Release 78-91)

• NASA announced it had selected Hughes Aircraft Co.'s Space and Communications Group for negotiations leading to a contract for development of a Jupiter atmospheric-entry probe, part of the Galileo mission scheduled for launch in Jan. 1982. The mission would consist of an orbiter to circle the planet for 20mo as well as a probe to plunge into Jupiter's atmosphere, surviving high-speed entry of 48km/sec (20 000mph) and a pressure of more than 10 earth atmospheres, to transmit information on Jupiter's composition, structure, and cloud physics. Estimated cost of the contract would be about $35 million, most of the work to be performed under subcontract by the General Electric Co. Hughes would design, develop, and fabricate the protoflight probe, integrate the science instruments, and test and provide systems integration and launch support. Project Galileo had been named in honor of the 16th-century Italian astronomer; it was a cooperative project of NASA's JPL and ARC, with the Federal Republic of Germany providing the orbiter's retropropulsion motor and some of the science instruments. (NASA Release 78-92)

• Mstislav Keldysh, Soviet scientist and mathematician who had been spokesman for the USSR's space program as head of the Soviet Academy of Sciences, died June 24 at the age of 67, the *Washington Post* reported. Soviet news agency Tass described the death as sudden. Dr. Michael DeBakey had traveled to the Soviet Union 5yr ago to operate on Keldysh's circulatory system.

Recognized in a wide range of scientific and mathematical disciplines bearing on aviation and rocketry, Keldysh had proved his administrative ability by rising to the top of his country's scientific establishment. President of the Soviet Academy of Sciences from 1961 to 1975, Keldysh had been not only USSR science spokesman but also a key figure in organizing and developing scientific research throughout the Soviet Union. He had won the Stalin Prize in 1942 for "The Theory of Calculating and Developing Methods of Reducing Various Types of Vibrations in Aircraft," and in 1946 for "The Front-Wheel Shimmy of the Tricycle (Aircraft) Landing Gear." In 1943, Keldysh had become head of a top secret aircraft-development institute with increasing administrative responsibilities. As head of the Academy of Sciences, he announced in Oct. 1969, shortly after the U.S. had put men on the moon, that the USSR had abandoned plans to do likewise and would concentrate on putting manned space stations into orbit around the earth. He acknowledged that the Soviet Union had been debating space expenditures, and said, "My personal view is that, when a man has taken his first step into space, you cannot stop further development." (*W Post,* June 27/78, B6; FBIS, Tass Intl Serv in Russian, June 26/78)

June 28: NASA declared the launch of two satellites had been successful, Japan's direct broadcast satellite *BSE* and ESA's orbital test satellite *Ots 2*. A Delta had launched *BSE* into a synchronous transfer orbit from ETR at 5:01pm EST Apr. 7, 1978, with 35 923km apogee, 166.1km perigee, 27.2° inclination. Satellite performance was satisfactory during the transfer orbit. The boost motor had fired at 7:34pm EST Apr. 8 to move the satellite over the South Pacific to a position at approximately 110°E above the equator south of Japan. All subsystem functional checks had indicated satisfactory satellite status.

NASA had launched Ots B (*Ots 2* in orbit) at 6:59pm EDT May 11 from ETR on a Delta into a synchronous transfer orbit with 35 946km apogee, 183.6km perigee, and 27.4° inclination. Satellite performance was satisfactory during the transfer orbit. The boost motor had fired at 8am EDT May 13, to move the satellite over the South Atlantic to a position 10°E above the equator. All subsystem functional checks had indicated satisfactory satellite status. This was the first flight of the Delta 3914 (Castor IV) configuration since failure of the OTS-A mission in Sept. 1977. (MOR M-492-212-78-01 [postlaunch] and M-492-210-78-02 [postlaunch], both June 28/78)

- MSFC reported that a new 0.8km (0.5mi) antenna range had operated satisfactorily in testing Space Shuttle antennas for range safety. The new range had a 27.4m (90ft) transmit tower and a 22.8m (70ft) model test tower. Antenna tests had begun in May on a 1/15-scale model of the

Space Shuttle orbiter, external tank, and two solid-fuel rocket boosters installed in the tower.

Engineers had measured radiation patterns of the six range-safety antennas (two on the ET and two on each of the 2 SRBs) to ensure that a signal from the range-safety officer would reach the vehicle at any altitude. The range-safety antenna system was interconnected to immediately relay to the ET and both SRBs a destruct signal received on any one of the six antennas. Future Shuttle tests possibly requiring antenna-pattern measurements included the teleoperator retrieval system, 25kw power module, large space structures, and satellite power systems. (*Marshall Star,* June 28/78, 1)

- ESA reported it had agreed to sign June 30 the first license it had granted for use of one of its patents: the Italian electronics company SELI would get industrial-production rights to an ESA-patented computer terminal that could display two texts written in different alphabets side by side on the same screen. Under the agreement, SELI would have exclusive production rights to the terminal for 2yr.

This invention was an example of technological spinoff from space activities put to practical use. One version of the system, the "Eurab terminal," could display on the same screen one text in Arabic and another in Latin characters; although originally developed for Arabic, the system could display any alphabet. The Eurab terminal could show the Arabic alphabet with vowels included, making reading easier and unambiguous, and leading to wider use of Arabic in airports, banks, schools, television programs, or wherever display screens might be used. (ESA Release June 28/78)

- The *Chicago Tribune* reported that the USSR had launched *Soyuz 30* June 27 carrying a Soviet commander, Pyotr Klimuk, and the world's first Polish cosmonaut, Miroslaw Hermaszewski. *Soyuz 30* would dock with the *Salyut 6/Soyuz 29* complex occupied since June 15 by Soviet cosmonauts Vladimir Kovalenok and Alexander Ivanchenkov. Hermaszewski had been trained under the Soviet Union's ongoing Intercosmos program to include eastern European countries in the Soviet space effort.

The international crew would study the manufacture of semiconductor materials under conditions of weightlessness, assess the effect of spaceflight on humans, observe and photograph land and oceans, and carry out technical experiments with individual onboard systems and the orbital complex as a whole. (*C Trib,* June 28/78, 1-3; FBIS, Tass in English, June 28/78)

- The *Washington Star* reported that, despite Soviet efforts to suppress news of the incident, western sources said that in Feb. a Soviet cosmonaut had narrowly avoided hurtling off to his death in space. The near-mishap had occurred during an unauthorized spacewalk by cosmonaut Yuri Romanenko on the record-breaking 96-day orbital flight aboard the *Salyut 6* space station. Only cosmonaut Georgy Grechko had been slated to make a spacewalk; however, both cosmonauts had been wearing a new type of spacesuit that included a radio and an hr's supply of oxygen, with only a simple tether to the spacecraft to keep the cosmonaut from drifting away. During the Grechko spacewalk, after the Salyut had passed over the western Pacific and was out of range of Soviet ground stations, Romanenko (who was untethered) had jumped out of the open hatch. Why he did this remained unknown, although a U.S. space official speculated he might have gotten "space rapture." Grechko had been able to grab the end of Romanenko's safety line just before it passed out of his reach. (*W Star,* June 28/78, A4)

June 30: NASA announced it had selected Pan American World Airways, Inc., Aerospace Services Division, for negotiations leading to award of a contract for support services to facility operations at the National Space Technology Laboratories in Miss. Estimated cost over the first 3yr of the cost-plus-award-fee contract would be $32 million, with two 1-yr unpriced options. The contractor would operate and maintain NSTL real and installed property; manage supplies and equipment; and provide institutional, construction, and installation services. (NASA Release 78-94)

- DFRC announced it had begun a 2 wk flight program with Calspan Corp., using the total inflight simulator (TIFTS) to investigate advanced flight-control systems like those used in the Space Shuttle. TIFTS, a small twin-engine commercial passenger aircraft with the nose modified to include an additional pilot's cockpit, was one of the largest airborne simulators equipped with variable stability and 6 deg of freedom. Test pilots had flown the simulated mission from the nose cockpit (with safety pilots in the normal cockpit) to improve understanding of the flying qualities of advanced craft when landing, especially in actual touchdown under differing pilot-task conditions. (*DFRC X-Press,* June 30/78, 2)

- On the day *Soyuz 30* cosmonauts had docked with *Salyut 6,* the USSR had launched from Plesetsk another satellite in what was believed to be its early warning satellite system, followed by launch of a new space-mission series, *Defense/Space Business Daily* reported. On June 8 Tass had announced launch of eight Cosmos satellites (*Cosmos 1013-1020*) on one booster rocket. The early-warning spacecraft, *Cosmos 1024,* had gone into a Molniya (communications satellite) type of orbit with parameters of 630/40 000km, 62.8° inclination, and 12hr 6min period. It was the first of this type of mission launched in 1978; three had been launched in 1977.

The USSR had initiated a new spacecraft-mission series with the launch of *Cosmos 1025*, put by observers in the general category of military monitors but following a regime used by special-research missions. This was the 45th Soviet space mission in 1978, three more than at this point in 1977. The 1978 missions had been 77% military (not including the four Soyuz missions that had direct military application in manned reconnaissance/surveillance). (*D/SBD*, June 30/78, 307; FBIS, Tass in English, June 8/78)

During June: NASA reported that the Society of Automotive Engineers (SAE) had awarded Dr. Jose Chirivella and Wesley Menard of JPL the 1977 Manly Memorial Award for the best annual paper dealing with engines. Dr. Chirivella, principal investigator of hydrogen enrichment in the aircraft piston-engine program, and Menard, supervisor of JPL's combustion research group, had achieved fuel savings of 10 to 20% in aircraft piston engines. The aeronautical-propulsion division of NASA's Office of Aeronautics and Space Technology had supported the research. (*NASA Activities*, June 78, 11)

• NASA's annual procurement report for FY77 said that agency procurements had totaled $3532 million, a 10.2% increase over FY76. Approximately 80% of the net dollar value had been placed directly with business firms, 5% with educational and other nonprofit institutions or organizations, 8% with the Calif. Inst. of Technology (for operations conducted by or through JPL), and 6% with or through other government agencies. Of procurements placed by NASA with other government agencies, 90% had resulted in contracts with industry; about 48% of funds under JPL contracts had been for subcontracts with or purchases from business firms. Thus, about 90% of NASA's procurement dollars had gone directly or indirectly to private industry.

Of total direct awards to business firms, 73% were competitive procurements. Small business firms had received $255 million (only 9%) of these direct awards, since most of them were for large continuing R&D contracts for major systems and items of hardware, generally beyond the prime contractor capability of a small business. However, small business had received $119 million (22%) of the $522 million in new contracts worth $10 000 and more with business firms. Small business had also received $496 million (18%) of subcontract awards from 87 of NASA's prime contractors, including $59.382 million awarded to minority small business enterprises.

During 1977, 48 states and Washington, D.C., had participated in NASA prime-contract awards of $10 000 and over, 83% of which were placed in labor-surplus areas located in 41 states. Of NASA's prime contractors, 86% reported their larger subcontract awards had gone to 1684 different subcontractors in 45 states and Washington, D.C. (NASA procur rpt FY77)

- The USAF announced that SAMSO had awarded three cost-plus-incentive contracts for the first three stages of the MX missile system. Systems-definition contracts had gone to Thiokol Corp.'s Wasatch Division, $4 635 775; Aerojet Solid Propulsion Co., $3 445 066 (stage two); and Hercules, Inc., $3 493 191 (stage three). A requirement to design explosive ordnance-initiation devices for stage separation and thrust termination accompanied the stage-one contract with Thiokol Corp.

The 3-stage system-definition contracts called for studies, analyses, systems engineering, and missile/stage-interface definition to be completed by the end of 1978. Options for full-scale engineering development would include design, development, fabrication, and testing of hardware for the three stages. The MX program, a follow-on to the Minuteman intercontinental ballistic missile, was aimed at ensuring the survivability and effectiveness of U.S. ICBMs. (AFSC *Newsreview,* June 78, 3)

- The USAF announced it had issued to industry an RFP to investigate the feasibility of using widebody aircraft to supplement the B-52 as cruise-missile carriers. RFPs to aid in selecting one or more contractors had gone to Boeing, Lockheed, and McDonnell Douglas, all producers of domestic widebody transport aircraft. Proposals called for concept-tradeoff and design studies to verify aircraft suitability for the carrier mission. The studies would include the prototype widebody aircraft built by Boeing and McDonnell Douglas for the advanced medium short-takeoff-and-landing (STOL) transport program. Subsequent developmental efforts were in the planning stage. (AFSC *Newsreview,* June 78, 16)

- ESA reported that its council and communications satellites program board had unanimously approved at March and April meetings a first series of five operational Ariane launchers [see Apr. 24]; two operational satellites for intra-European telephone, telegraph, and telex communications and television relay (ECS-1 and -2); and a second maritime-communications satellite (Marots-B). Three of the five Ariane launchers would be financed from ESA programs for the scientific satellite Exosat (to be launched in early 1981), Marots-B (mid-1981), and ESC-1 (end of 1981). One launcher had been earmarked for the French earth-observation satellite SPOT; the fifth launcher was a reserve.

The council also had agreed that a preliminary phase of the H-sat program should revise the proposed satellite design to require only minor modifications (reducing the time scale) to go from an experimental "heavy" platform and payload to an operating direct-broadcast satellite. Other design modifications required to move from a qualification to an operational Ariane had delayed the scheduled H-sat launch. (ESA newsletter, June 78, 2)

• The NAA newsletter reported that competition had become more intense for world-record flights in general aviation. Robert Mucklestone was attempting to regain his around the world title in Class C-1.c Group 1 (2204 to 3858lb) that he had first captured in 1975 from Dr. Alvin Marks, who in 1969 had beaten the record of British aviatrix Sheila Scott, who had traveled a 33 000mi route in 33 days with a total average speed of 36.15mph, including ground time. In 1977 Harold Benham and Jack Rood in a Beechcraft Bonanza Model 35 had bested Mucklestone's record. Whatever the outcome of Mucklestone's current flight, two Texans (William Wisner and Frank Haile) had planned a flight in July 1978 to break the record in that class. (NAA newsletter, June 78, 7)

• Researcher William Bainbridge, who had polled registered voters in the Seattle area about attitudes on the space program, reported widespread enthusiasm for the knowledge and practical benefits derived from the space program, *Astronautics and Aeronautics* magazine said. Bainbridge had offered his poll sample a set of 49 statements as "not good," "moderately good," or "extremely good" reasons for continuing the space program: communications satellite benefits had received most positive responses; scientific knowledge attained through space exploration ranked second. The unconventional idea that ranked highest—communication with extraterrestrial intelligence—was approved by 53% of those polled. Bainbridge felt his results showed public appreciation of the practical and scientific results of the space program, and an anticipation of more benefits from new projects. (*A&A*, June 78, 60)

July

July 2: The ***Washington Post*** reported that, as a result of belated discovery that Soviet radar in Europe would interfere with two NASA satellites scheduled for launch in 1980 to communicate with orbiting spacecraft, NASA would have to spend $100 million to redesign the satellites' electronic systems. NASA had awarded Western Union a $786 million contract to build six 5000lb tracking and data-relay satellites (giant orbiting transmitters and receivers, each carrying two umbrella-like antennas weighing 50lb apiece and unfurling in orbit to a diameter of 16.5ft) that would have replaced 60% of NASA ground-station antennas at an estimated saving of more than $100 million a yr. The 3-mo delay necessary for redesign was important because it would affect communications with the Space Shuttle; failure by the Pentagon and the CIA to warn NASA of the size and scope of Soviet communications interference in high-orbit regions had delayed discovery of the problem.

NASA testimony before two Senate committees revealed that Soviet radars from the Baltic to the Black Sea were emitting beams that converged high over the Atlantic and Pacific in the exact places NASA wanted to put the TDRS. Built to replace obsolete and expensive ground antennas at Ascension Island; Quito, Ecuador; Santiago, Chile; Guam; and Hawaii, the TDRS would improve communications by allowing ground controllers to talk to other satellites and Space Shuttle astronauts during more than 90% of each earth orbit. The electronic interference was said to have been unintentional. NASA "did not fully understand the environment and the effects it would have on the system," said C. Curtis Johnson, satellite project manager at Goddard Space Flight Center. "Otherwise, we would have been more careful in the specifications of the system." NASA had considered reducing the number of satellites on order from six to four to save $100 million, estimated cost of the redesign. (*W Post,* July 2/78, A1)

July 5: NASA announced it had awarded Computer Sciences Corp., Falls Church, Va., a $40 million contract for 3yr of institutional computer systems engineering, development, and production operations work at Johnson Space Center. Under JSC management, the corporation would perform systems engineering and definition, applied software development, and computer systems and related facility planning and development for the central computing facility, as well as computer operations, equipment operations, job scheduling and processing, dispatch services, job quality control, maintenance of tape libraries, production coordination, and other related tasks for the facility and mission control center. (NASA Release 78-95; JSC Release 78-29)

- NASA announced it had awarded Martin Marietta Corp. a $32 million contract to develop a teleoperator retrieval system (TRS), a reusable TV-equipped propulsive device for use by Space Shuttle crews to deliver, stabilize, and recover satellites in orbit. Managed by Marshall Space Flight Center, the contract called for delivery of flight hardware by September 1979.

The TRS, a low-thrust box-like spacecraft operated from the Space Shuttle by remote control, could be carried in the orbiter cargo bay or left in space after completion of a mission for retrieval by the next Space Shuttle. First mission for the TRS would be a docking with Skylab to boost it into higher orbit or to aid a controlled reentry; a camera on the forward end of the TRS would permit an astronaut to maneuver it for rendezvous and docking, or for other purposes. The TRS would return to the Space Shuttle using its own guidance and control system. (NASA Release 78-96; *Marshall Star,* July 5/78, 1; *DFRC X-Press,* July 14/78, 2; *JSC Roundup,* July 7/78, 1)

- Kennedy Space Center announced it had awarded Boeing Services International, Inc., a 1-yr $24 071 643 extension of a ground-systems operational contract, which brought the contract total to $67 143 012. Services by Boeing would include facility and utility operations and maintenance for propellants; cranes, doors, and platforms; elevators; services and shops; nondestructive evaluation; and life support and industrial operations. (KSC Release 63-78)

- MSFC reported that electronic simulators for Space Shuttle main engines, solid-fuel rocket boosters, and external tanks had passed tests designed to check the Shuttle's avionics during simulated missions. JSC would conduct Shuttle-flight simulations in a Shuttle avionics integration laboratory (SAIL) for which MSFC engineers had provided a mated elements system. All Shuttle avionics would work together in the SAIL for the first time in Shuttle-flight simulation that would include part of the countdown under normal, abnormal, and certain failure conditions. (*Marshall Star,* July 5/78, 2)

July 6: NASA reported that the 200kw experimental wind turbine generator managed by Lewis Research Center had completed more than 1000hr of operation for DOE in Clayton, N.M., and was ready for checks to verify design-life estimates. Twin rotor blades and other dynamic components that had rotated at 40rpm or more (making more than a million cycles) since the machine began operating in January had developed loose or missing rivets and three small 3-in cracks, and would undergo more detailed inspection. Although DOE had shipped the blades to LeRC for detailed inspection and analysis of their wear and life potential, the turbine had continued operation using rotor blades from the prototype wind turbine operated on an experimental basis near Sandusky, Ohio, since October 1975. The first U.S. federally sponsored wind system to produce electricity directly for a community power system, the turbine had supplied more than 100 000kw-hr of electrical power to the Clayton-owned utility system. (NASA Release 78-97)

- NASA announced that 35 new astronaut candidates would report to JSC July 10 to begin 2yr of training and evaluation, including life-support and ejection-seat training for the T-38 aircraft, aircraft physiological training, and T-38 aircraft systems and operations. In Aug., the candidates would take the standard USAF water-survival course at Homestead AFB in Fla., and would attend lectures on spaceflight history, technical-assignment methods and procedures in the astronaut office, manned-spacecraft engineering, Space Shuttle program, aerodynamics, flight operations, and the many disciplines associated with preparing and operating vehicles in space. Astronauts, engineers, and JSC management and support contractors would be instructors and lecturers. (NASA Release 78-98; *JSC Roundup,* July 7/78, 1; *Marshall Star,* July 19/78, 2)

- NASA announced that HiMAT (highly maneuverable aircraft technology), a flight-research vehicle to demonstrate advanced technologies for air superiority fighter concepts in the 1990s, would begin flight tests later in 1978. Engineering studies had indicated the HiMAT would have twice the turning capacity of the most maneuverable fighter, doing 8g turns at near-supersonic (6g turns at supersonic) speeds with no loss of speed or altitude.

NASA and the USAF had jointly designed the craft to hasten the transfer of advances in aeronautical design from research laboratories into flight testing and to expand design techniques leading to quantum jumps in performance from one generation of aircraft to the next. HiMAT would exploit the "undirectional" stiffness of advanced composite materials in its wings and canard (small forward-wing) surfaces, layering the composite material to capitalize on natural bending of the wing/canard during flight. The HiMAT design would combine for the first time the lift of the wing and canard to enhance maneuverability and controllability. NASA would use the remotely-piloted technique it had developed, to fly HiMAT in high-risk flight testing without risking a test pilot and to reduce the costs of man-rating the aircraft. Built by

Rockwell Intl. Corp.'s Los Angeles Aircraft Division, HiMAT was one of NASA's many aeronautics R&D efforts aimed at maintaining U.S. superiority in civil and military aviation. (NASA Release 78-99)

July 7: NASA announced that a USAF launch team, members of the 6595th Space Test Group, and a team from the Jet Propulsion Laboratory had launched NASA's SeaSat-A at 6:12pm June 26 from Vandenberg AFB on a USAF/General Dynamics Atlas F/Lockheed Agena. Launch sequence went smoothly, with orbit insertions at launch plus 57min over the east coast of Africa. The satellite, called *SeaSat 1* in orbit, had deployed its solar panels and communications and sensor antennas during the second and third orbits, and extended its synthetic aperture radar antenna about 10pm. Spacecraft and booster problems had delayed launch since May; program officials had feared additional postponements would jeopardize the use of *SeaSat 1* in ocean-monitoring programs to confirm the accuracy of the data it returned. Lockheed Missiles and Space Co. had built the spacecraft for NASA and integrated its sensors. (*JPL Universe,* July 7/78, 1)

• KSC reported that NASA's 4-engine Jetstar aircraft had completed the second of five flight tests of the microwave scanning beam landing system (MSBLS) installed at the orbiter landing facility. The first three flight tests were to verify the system's ability to land the unpowered Space Shuttle orbiter safely on the 15 000ft runway; the final two would be to commission (declare operational) the runway-landing system. Because orbiters could approach KSC from either the northwest or southeast, the center would have to commission the system twice. Each of the first tests had taken about a week, as the Jetstar had made daily 2hr passes over the runway at different altitudes and azimuths. Precision laser tracking system instrumentation that could locate an aircraft at distances of 14mi and altitudes of 100 to 20 000ft had locked on to special instrumentation in the Jetstar, continuously tape recording the Jetstar's position while the MSBLS tape recorded the same data. The tapes had been fed into a computer and compared; any positional errors in the MSBLS could then be corrected, aligning the landing system. (*Spaceport News,* July 7/78, 2)

• JSC had updated data from the two Voyager spacecraft, the *JSC Roundup* reported, to show them on course and (as of July 1) 425 875 313mi (*Voyager 1*) and 408 475 978mi (*Voyager 2*) from earth. *Voyager 1* was 152 714 714mi from Jupiter; *Voyager 2,* 172 112 418mi; *Voyager 1* was 651 024 027mi from Saturn; *Voyager 2,* 651 229 423mi. *Voyager 1* would encounter Jupiter on March 5, 1979; *Voyager 2* on July 9, 1979. JPL had been managing the Voyager program and providing deep-space tracking. Roundtrip communications had taken 76min for *Voyager 1* and 72min for *Voyager 2.* (*JSC Roundup,* July 7/78, 4)

July 10: The U.S. Navy had orbited two clusters of ocean-surveillance satellites to monitor radio communications and radar emissions from Soviet submarines and ships, and would add more spacecraft to expand coverage, *Av Wk* reported. The Navy had launched the first of the two clusters (each consisting of three small satellites in close proximity) in 1976, the second cluster in 1977, all from Vandenberg AFB into near-circular 63°-inclination orbits at 700mi altitudes. At that altitude, the spacecraft could receive signals from surface vessels more than 2000mi away.

The Naval Research Laboratory, which in Dec. 1971 had built and launched three spacecraft as a first demonstration of using multiple satellites to direction-find and eavesdrop on Soviet surface vessels and submarines, had designed and built the ocean-surveillance satellites (NOSS). Martin Marietta had begun production of additional satellites with E-Systems, Inc., as major subcontractor to provide the electronic intelligence (elint) receivers and antennas. For the future, the Navy had planned a more advanced spaceborne ocean-surveillance system using active radar to pinpoint the position of surface vessels, to be developed for launch by 1983 under a program called Clipper Bow. (*AvWk,* July 10/78, 22)

July 11: NASA announced it had selected General Electric Co., Valley Forge, Pa., to provide a Landsat-D mission system consisting of a flight segment (and backup) and a ground segment that would include a data management system, an operations control center, a Landsat assessment system, and a transportable ground station, all to be managed by GSFC. General Electric would fabricate the mission-unique equipment and integrate and test the flight segments, as well as build and install the ground segment in government facilities. Proposed cost of the cost-plus-award-fee contract was approximately $70.5 million, to cover the Landsat-D launch in late 1981 and early orbital operations.

The thematic mapper (TM) in Landsat-D's instrument module, a second-generation 7-band multispectral scanning radiometer with a ground resolution of about 30m (100ft), could extend the inventorying of earth resources. NASA had designed Landsat-D to improve activities such as crop forecasting, vegetation-health assessment, forest- and range-resources management, water-resources management, land-use mapping, and mineral exploration. (NASA Release 78-102)

- ESA announced that Europe's first comsat, *Ots 2,* had been operating correctly at the end of the 8-wk period covered by an insurance contract.

Ots 2, launched May 12 from Cape Canaveral, had reached its final station 35 900km above the equator at 10°E. Its six SHF antennas would cover western Europe, the Middle East, north Africa, the Azores, the Canary Islands, Madeira, and Iceland. *Ots 2* had successfully exchanged signals with four large earth stations and eight stations equipped with small antennas. Checks and preliminary tests would continue until the end of September, when ESA would turn over *Ots 2* to its users, national telecommunications administrations grouped in interim Eutelsat and European research units and centers. The experimental program would include telephone and television traffic-routing tests, propagation experiments, and a variety of experiments related to new comsat applications in Europe. (ESA Release July 11/78)

July 12: NASA announced it had awarded TRW Defense and Space Systems Group, Redondo Beach, Calif., a contract for the materials processing in space (Spacelab) program at an estimated cost of approximately $9.7 million. TRW would be prime contractor for various aspects of the Materials Processing in Space (MPS) program, the contract to cover the initial phase of the MPS Spacelab-payloads project expected to begin in September 1978 and continue through 1981. TRW would develop (and support the operation of) specialized and general purpose payload systems that would accommodate a variety of different materials processing experiments during recurring earth orbit missions of the Space Shuttle.

NASA had selected the first series of experiments from among proposals by scientists from the U.S. and numerous foreign countries. Objectives of the MPS program were to study new or improved processes and to identify candidate products of initial commercial interest: electronic materials, metals, glasses, and certain chemicals produced by processes such as crystal growth, solidification, and containerless processing. MSFC would manage operational aspects of the program. (NASA Release 78-103; *ARC Astrogram,* July 27/78, 3)

• Cosmonaut Valery Kubasov had spoken of the possibility of joint experimental flights by the USSR's Salyut-type orbital station and the U.S. Space Shuttle, according to a Tass report. Kubasov noted that such flights could use the joint approach and docking procedures worked out for the Apollo-Soyuz test project and tested during the joint Soviet-U.S. flight of Apollo and Soyuz in July 1975. A new agreement between the USSR and the U.S. on cooperation in space research for peaceful purposes had came into force the previous May, Kubasov pointed out. He added that millions of Americans, like the citizens of the USSR, had viewed the Soyuz-Apollo program as a display of goodwill by the two nations and the beginning of great cooperation between nations in space.

However, *Av Wk* reported that any U.S. Space Shuttle/Soviet Salyut space station joint mission was in deep trouble, if not already dead, because of increased U.S. concern over technology transfer to the Soviets and the current abrasive political climate between the two countries. A NSC interagency committee had reevaluated the entire joint mission idea, while U.S./Soviet discussions on the project were in limbo. The project probably would have been discussed during a planned technology-oriented trip to the USSR by presidential science adviser Frank Press, but the White House had canceled the trip in disapproval of the Soviet treatment of dissidents. (FBIS, Tass Intl Svc in Russian, July 12/78; *AvWk,* July 17/78, 13)

July 13: KSC announced that for the third consecutive yr it would host about 80 of the nation's leading atmospheric physicists and lightning researchers, representing 10 universities, 2 research laboratories, NOAA, and 3 other NASA centers, for a summer of combined study of the electrical properties of thunderstorms. The thunderstorm research international program (TRIP) would use the unique meteorological facilities built at KSC during the Apollo and Skylab programs, to assess thunderstorm hazards during launch operations and to monitor the high incidence of lightning-charged storms in the area during the summer. Participating investigators would bring their own instruments for many of the experiments; others would use KSC's instruments, like the field-mill system built for the Apollo program to detect buildup of electrical charges in overhead thunderclouds; KSC's instrumented aircraft, NASA-6, used in previous lightning studies; and the lightning detection and ranging (LDAR) system that detected electrification in distant clouds. NOAA's geosynchronous operational environmental satellite *Goes* would provide satellite photographs for the scientists.

Experiments would include an evaluation of prototype lightning sensors as part of the scientific package to be flown in 1982 on the Jupiter orbiter probe designated Project Galileo, first planetary spacecraft to be carried aboard the Space Shuttle; a study of evolution of lightning activity; examination of the structure of waveforms radiated from lightning, for characteristics indicating storm type; obtaining from ground-based systems range and azimuth data on lightning strokes; monitoring of electric-field and corona (surface discharge of electricity) current over water; and study of the relationship of precipitation-formation development in thunderclouds to lightning occurrences. (KSC Release 66-78; *Spaceport News,* July 21/78, 1)

• Langley Research Center announced it had selected Frank Godfrey, contract specialist, to participate in the Education for Public Management program of the John F. Kennedy School of Government at Harvard Univ. As part of a federal government effort to develop promising mid-careerists' talents and abilities for management in the public sector, the program would train individuals identified by their agencies as having potential to assume increased responsibility for agency programs and policies. Godfrey, who had been at LaRC since 1974, had served as a loaned executive to the 1977 Peninsula United Fund Campaign and was on the adjunct faculty of St. Leo College. (LaRC Release 78-35)

July 16: NOAA announced it had developed a technique that would permit national weather centers around the world to monitor rainfall over agricultural areas, detect potential flash-flood situations, and predict rainfall from hurricanes while they were still at sea. Once the technique had been perfected, automated, and put into operation, scientists could use earth-orbiting satellites to estimate rainfall from convective (vertically-developed) clouds and to monitor the movement and distribution of precipitation over the planet's entire surface.

Dr. William Woodley and Cecilia Griffith of the Commerce Department's National Hurricane and Experimental Meteorology Laboratory had adapted the experimental method from a similar system of estimating rainfall from convective weather systems in the tropics, applied successfully during cloud-seeding experiments in southern Fla. The imagery had revealed a difference between young rain-producing clouds and dying rainless systems, both of which had appeared in bright shades on satellite images. NOAA's National Weather Service had already made quasi-operational use of a similar method, applied by flood forecasters in predicting flood potential of approaching hurricanes and large thunderstorms. Woodley and Griffith had begun to use the technique in a real-time warning mode to detect potential flash flood situations. (NOAA Release 78-94)

July 17: Worldwide demand for international satellite communications would increase by more than 100% in the next 5yr, INTELSAT announced. The prediction came out of the fourth global telecommunications traffic meeting sponsored by INTELSAT, in which 172 international communications experts representing 93 telecommunications entities around the world participated. Purpose of the annual meeting was to forecast the demand for services provided by the INTELSAT system. INTELSAT would use these forecasts in configuring its system to meet user requirements with maximum efficiency, and in planning for future satellite systems.

Preliminary figures from the meeting indicated that global demand for satellite-telecommunications capacity would increase from 14 105 equivalent full-time simultaneous telephone circuits at year end 1978, to 29 282 circuits by the end of 1982, up 108%. The biggest demand was expected to be from countries surrrounding the Atlantic Ocean, where communications traffic by satellite was expected to rise by 114% over the next 5yr. Traffic in the Indian Ocean region was projected to increase by 98%, and in the Pacific Ocean region by 91%. (INTELSAT Releases 78-19-I, 78-20-I)

July 18: NASA reported that the Netherlands astronomical satellite *ANS* had been a success, based on comparison of mission results and prelaunch objectives. *ANS,* an Explorer-class x-ray and ultraviolet mission, was a cooperative program of the U.S. and the Netherlands, the U.S. providing a 2-part medium-energy x-ray instrument and the Scout launch vehicle, and the Netherlands providing the spacecraft, a 2-part soft x-ray instrument, and a small ultraviolet telescope with photometers. During its 20mo lifetime, *ANS* had measured positions, spectra, and time variations of galactic and extragalactic x-ray sources in the energy range 2 to 15keV; defined upper limits of silicon-line emissions around 2keV; and transmitted more than 18 000 observations of about 4000 objects in the UV range 1500 to 3300A, in addition to other unexpected discoveries.

Although an unplanned elliptical orbit had drastically limited the x-ray observations, particularly in the pointed mode, and had substantially increased the spacecraft's exposure to radiation, the data it had returned were of a consistently high quality, except for partial failure of half the soft x-ray instrument 10mo after launch. *ANS* had reentered the atmosphere June 14, 1977. (NASA MOR S-875-74-01 [postlaunch] July 18/76)

- NASA reported the U.S. Postal Service would commemorate the Viking missions to Mars by issuing a special postal stamp Thursday, July 20, second anniversary of the *Viking 1* landing on Mars. LaRC and the Postal Service would hold a First Day of Issue ceremony in LaRC's activity center, and Dr. Donald Hearth, center director, would buy the first stamp. Robert McCall, whose two large murals were on display in the National Air and Space Museum, had designed the stamp.

NASA had launched two Viking spacecraft toward Mars in Aug. and Sept. 1975; the *Viking 1* lander had touched down on Mars at 8:12am EDT July 20, 1976, and the *Viking 2* lander arrived at 6:59pm EDT Sept. 3, 1976. During the mission ending in Nov. 1976, the landers and their partner, the orbiter spacecraft, had conducted experiments in 13 scientific disciplines. NASA had extended a reduced Viking mission until May 1978 to gather more information on Mars's weather, seasonal variations, and soil characteristics; a further reduced mission controlled by JPL would continue through Feb. 1979. The Viking high-resolution photographs of the planet from the surface and from orbit, numbering more than 30 000, had mapped most of Mars and had provided scientists with valuable information. (NASA Release 78-106; LaRC Release 78-34; *Langley Researcher,* July 14/78, 1)

July 19: NASA announced that the Egyptian government had reserved four small self-contained payloads to fly on the Space Shuttle in the 1980s. At the NASA Hq ceremony July 13, Dr. Mohamed Shakar, minister of the embassy of Egypt, and Dr. Farouk El-Baz, research director for the Smithsonian Institution's Center for Earth and Planetary Studies, gave NASA officials a down payment to reserve Space Shuttle space.

The payloads called "getaway specials," each weighing no more than 90kg (200lb) and no larger than $0.5m^3$ ($5ft^3$), would fly on a space-available basis. NASA had received payments for about 240 small payloads so far; purchasers had included private individuals, commercial firms, and foreign countries. The Egyptian purchase marked the first foreign educational use of a Shuttle payload, as Egyptian students would compete in proposing experiments for the Shuttle missions. Dr. El-Baz would direct evaluation of the proposals. (NASA Release 78-107)

• NASA announced that Dr. Robert Frosch, NASA administrator, and Professor S. Dhawan, secretary of the department of space and chairman of the Space Commission, Government of India, had signed a memorandum of understanding (MOU) July 18 for launch in 1981 from the Space Shuttle of India's first national satellite, INSAT-1. INSAT-1, a multipurpose spacecraft in geostationary orbit, would provide India with domestic public telecommunications and direct TV broadcasting and meteorology services. This was the first MOU NASA had signed with a foreign government setting forth terms and conditions under which NASA would furnish Space Transportation System launch services on a reimbursable basis. (NASA Release 78-109)

• NASA announced that Puerto Rico's governor Carlos Romero Barcelo and officials from DOE, NASA Hq, and LeRC would dedicate on July 21 the federal government's second large wind-turbine generator to be field-tested by a U.S. utility, on the small Puerto Rican island of Culebra. NASA had designed the turbine to produce 200kw of electric power in winds of 29 to 60kph (18 to 34mph) measured 9m (30ft) above ground level, equal to 20% of Culebra's electric power, or about enough power for 150 island homes. The Puerto Rico Water Resources Authority would operate the wind turbine for 2yr, supplying test data to DOE and NASA on the performance and economics of large wind-energy systems used by utilities. Later in the yr NASA planned to begin operation of a much larger wind turbine rated at 2000kw (2mw) near Boone, N.C. (NASA Release 78-104; DOE Release R-78-266)

• MSFC reported that a failure in Skylab's power system July 9 had caused loss of vehicle attitude; MSFC engineers had reconfigured the system and fully charged the spacecraft's batteries, before performing reorientation maneuvers to return it to its minimum-drag attitude. Skylab was now about 240mi above earth, rolling at about 2 revolutions per hr. Engineers had planned maneuvers to stop the roll and place the vehicle first in a solar-inertial attitude, then in an end-on velocity vector that would encounter minimum atmospheric drag. However, Dr. Chris Kraft, JSC director, said in a copyrighted interview with the *Dallas Morning News* reported in the *Washington Post*: "I don't believe Skylab is going to live long enough for us to get to it with the Space Shuttle . . . We're going to have to live with the fact that Skylab is going to die a natural death." (*Marshall Star*, July 19/78, 1, July 12/78, 1; *JSC Roundup*, July 21/78, 1; *ARC Astrogram*, July 13/78; 1; *W Post*, July 21/78, A14)

- MSFC announced that ISEE-C, third and last of the spacecraft in a joint NASA/ESA study of near-earth environment, would be launched August 12. *Isee 1* and *2* built by ESA had, since they were launched into looping trajectories Oct. 22, 1977, been gathering detailed data on solar-wind particle control of the boundaries between earth space and interplanetary space. ISEE-C, at a point in a sun-centered orbit where gravitational forces of the earth and sun were exactly equal, should obtain nearly continuous data on the fluctuating solar wind and on special solar phenomena, about an hr before the solar particles would flow past the earth orbit of *Isee 1* and *2*. (*Marshall Star*, July 19/78, 4)

- GSFC reported that, after a 2mo search, its Copernicus satellite had located what might be a second invisible "black hole" in the universe. The satellite's x-ray experiment had found in the constellation Scorpio what was believed to be a super dense collapsed star with such strong gravity that even light could not escape it. Scientists had declared it much more active and convincing than the first black hole found, Cygnus X-1. The new black hole was orbiting Scorpio V-861, a supergiant star visible with the naked eye from earth, and gradually siphoning away the larger star's atmosphere.

Tracing the massive amounts of x-rays released from matter emanating from the giant star had led scientists to what they called the "best black hole yet"; discovery had given astronomers their first opportunity to study a black hole as it passed behind its companion star and to test some of their black-hole theories. Glen Pollard, coinvestigator on the project, said he hoped the new information would define the shape of the cloud of stellar material sucked into the black hole, reveal the dynamics of such systems, and provide a measure of the quantity of material being removed at speeds up to 2 million mph. Studying black holes would extend astronomers' knowledge of physics into areas not observable on earth—the physics of relativity. (*Goddard News*, July 19/78, 1)

• GSFC reported it had held in June the first regional remote-sensing applications training course for state-related users of remote-sensing systems. Participants represented agencies implementing or planning facilities to use Landsat image data. Developed by Dr. Nicholas Short, GSFC training officer, and Henry Robinson of CSC, the course had offered comprehensive explanations of image processing offered by expert lecturers drawn from NASA, outside agencies, and contractors. (*Goddard News*, July 19/78, 4)

• GSFC reported that its astronomers believed they were about to confirm for the first time the presence of gold on a star, perhaps as much as 100 billion tons of it. That amount of gold would indicate the star contained one part per 100 000, comparable to earth's one part per million. William Heacox and David Leckrone of GSFC's Stellar and Cosmic Astronomy Branch had planned additional observations to confirm the first signs of gold on Kappa Cancrii, a blue-white star visible to the naked eye in the constellation Cancer. The astronomers had found the gold traces on the star while using the IUE satellite to look at chemically peculiar stars rich in exotic elements. (*Goddard News*, July 19/78, 2)

• GSFC reported that U.S., Canadian, and other scientists had been studying the first data from the applications Explorer mission *Aem 1*, launched Apr. 26 into a polar orbit. Using information on day-night temperature changes, the scientists had examined black-and-white and false-color images for clues to the locations of mineral resources and to identify rock types, soil-moisture changes and plant stress, and the effects of urban heat islands. The first false-color image had covered a 700km swath of the eastern U.S. from Cape Hatteras to Lake Ontario. The scientists would correlate data from *Aem 1*, first of a series of satellites for NASA's heat-capacity mapping mission, with data from other satellites, especially Landsat. (*Goddard News*, July 19/78, 2)

• INTELSAT reported it had commissioned a $23 500 study in 1979 of ionosphere effects on communications-satellite transmissions. Cable and Wireless Ltd., U.K., in Hong Kong would conduct the study to discover the cause and extent of, and remedy for, fluctuations in satellite-signal strength noted by earth stations near the equator. The fluctuations in the 4 and 6GHz frequency band, believed to be caused by sunspot activity, had occurred only in the evenings, mainly during equinox periods, and had impaired international communications. As scientists had predicted

1979 would be a high sunspot-activity year, data gathered then would be vital to INTELSAT attempts to overcome such interference. (INTELSAT Release 78-21-I)

July 20: NASA announced that an Ames Research Center scientific team led by Univ. of Chicago astronomer Dr. Richard Miller and ARC astrophysicist Dr. Bruce Smith had been pioneering in computer simulations of cosmic events that might alter traditional ideas of how galaxies formed, what shapes they assumed, and what happened when they collided.

Using ARC's ILLIAC IV, world's most powerful computer, the researchers had recreated the birth and evolution of stars and galaxies, compressing 200 million yr into several hr of computer time and reducing the distance light traveled in 100 000yr to the length of a television screen, to witness galaxies colliding and gas clouds begetting embryonic stars. Computer simulations had shown elliptical galaxies, thought to be oblate (shaped like a frisbee), to have a 3-dimensional prolate shape (oblong); astronomers had found observational evidence confirming the computer discovery. The researchers had instructed the computer to create swirling systems of 100 000 computer points, each point representing the mass of about 1 million suns to give the simulated galaxy a realistic total mass. Each point had felt the gravitational pull of its neighbors and had absorbed energy from exploding supernova. Furnishing a computer with the power of ILLIAC IV with a detailed program on formation and dynamics of galaxies had proved computer simulation to be a useful approach to explaining basic astrophysical processes.

ARC scientists had filmed several computer simulations showing results unexpected in light of traditional astrophysical theories. For example, vast congregations of computer-generated stars had repeatedly evolved into stable prolate bars that rotated end over end to form what was perhaps the true shape of elliptical galaxies. When Miller and Smith had set two simulated 50 000-star galaxies on a collision course, the colliding galaxies had exhibited much greater interaction than was forecast. First they contracted, their gravitational fields reinforcing each other, then they bounced back in violent expansion flinging hundreds of stars out of the galaxies, resulting in merged galaxies containing considerably fewer stars. The two researchers' most recent efforts had centered on tracing simulated masses of gas as they coalesced and formed stars. (NASA Release 78-108)

- NASA announced that officials from DOE, the U.S. Forest Service, and LeRC had gathered atop a 2392m (7684ft) peak to dedicate a pioneer solar-cell-powered lookout tower that would demonstrate applications of solar-electric technology in the foreseeable future. The lookout tower, on Antelope Peak in Calif.'s Lassen National Forest, would use a 300w solar-cell system to power the tower's refrigerator, water pump, lights, radio-communications equipment, and small appliances used by a fire lookout who would live round the clock in the tower. Electricity generated by the solar cells would charge eighteen 12-volt lead/acid batteries, storing up to 36kw-hr of electric energy and supplying normal amounts of power for about a mo before needing recharge.

The tower's solar electric power system had been designed to operate continuously for a yr without fuel or periodic maintenance. LeRC had built the solar electric-power system funded by DOE through the Test and Applications Project managed by the center as part of DOE's photovoltaic conversion program. LeRC officials noted that, at current prices, electricity generated by solar-cell power systems over a 20yr system life would cost about $1.75 per kw-hr, which compared favorably with the price of electricity generated in remote areas by alternate methods such as diesel generators. (NASA Release 78-110; DOE Release R-78-270)

- The Naval Research Laboratory reported that a team of its space scientists had evaluated two new types of far-ultraviolet electrographic cameras. Designed for possible use in the Space Shuttle program to investigate radiation spectra of distant stars and other celestial objects, both cameras would use alkaline halide photocathodes having more sensitivity in the vacuum ultraviolet below 2000A, and higher angular resolution, than cameras previously used.

One camera, the internal-Schmidt-optics type, had an opaque photocathode like those NRL had used in previous sounding-rocket flights, in the lunar camera on the *Apollo 16* mission, and on *Skylab 4*. The new camera, flown on two sounding-rocket missions, had on the first flight obtained far-ultraviolet images of the Andromeda galaxy and on the second had recorded the North America nebula in Cygnus and far-ultraviolet spectra of stars in Cygnus. The other camera developed by NRL, a more conventional end-window type, had a semitransparent photocathode intended for possible use at the focus of a large telescope or for making spectrographs on the Spacelab. This large-format electrographic camera, instead of using a phosphor screen, would record directly on film the electrons emitted by the photocathode, allowing better resolution and photometric accuracy. NASA had supported development of the electrographic cameras. (NRL Release July 20/78)

July 21: After 2 decades as key booster in NASA's space program, the Atlas Centaur would remain "old reliable" for a variety of planetary, commercial, and military payloads launched in the 1980s, *Lewis News* reported. The Centaur project had begun in November 1958 when DOD's Advanced Research Project Agency (ARPA) awarded the first contract to General Dynamics after a study recommending a high-energy upper stage for the Atlas launch vehicle. Before the study, Pratt and Whitney had received a contract for a hydrogen/oxygen rocket engine. Since Centaur would be the first space-launch vehicle to use a liquid-hydrogen/liquid-oxygen combination, a whole new technology was needed for handling materials, behavior, fabrication, and testing of liquid hydrogen in a space environment, not only to make Centaur a success but also because this fuel was to be used for the upcoming Apollo program.

In 1958 Centaur received its first mission assignment, definition of geosynchronous orbit, and in 1960 its first deep-space mission. The creation of NASA resulted in transfer of the Centaur program from ARPA to NASA in July 1959. LeRC, which had pioneered research in hydrogen technology and had fired an experimental liquid-hydrogen/liquid-oxygen engine with 5000lb thrust as early as 1953, received technical management of Centaur in 1962. The first successful flight of an Atlas Centaur in Nov. 1963 included the world's first inflight ignition of a hydrogen/oxygen rocket engine. Centaur had proved its operational capability in 1965 by successfully injecting a dynamic model of the Surveyor spacecraft into a prescribed transfer trajectory, resulting in a simulated lunar-target impact.

After successfully launching *Surveyor* (for the first soft landing on the moon) and *Pioneer 11* (for a flyby of Jupiter), NASA in the mid-1960s had directed its efforts to integrating the Centaur with the USAF Titan booster. General Dynamics had built an improved Centaur adaptable to both the Atlas and the Titan boosters; Martin Marietta had conducted studies for NASA on integrating the Titan booster with an improved Centaur, and on modifications needed to the Titan launch facility at ETR.

Atlas Centaur missions had included earth-orbiting spacecraft such as the applications technology satellite, orbiting astronomical observatories, Comstar, high-energy astronomical observatories, and FltSatCom. Atlas Centaur, used for future missions with HEAO and FltSatCom spacecraft, would remain one of NASA's prime launch vehicles until the Space Shuttle became fully operational. (*Lewis News*, July 21/78, 1)

- In 1977 JPL scientists Donn Lynn and Jean Lorre had agreed to apply image-processing techniques to photographs of the Shroud of Turin, but had not expected their results to be published in newspapers and magazines around the world, *JPL Universe* reported. Their "mild curiosity" about the relic had introduced them to other American scientists who proposed using a variety of sophisticated tests to determine how the shroud had been imprinted. The result was a trip planned for Oct. that would take Lynn and Lorre to Turin, where church authorities would allow the American science team an unprecedented 24hr examination of the shroud itself.

Coinciding with a public exhibition and international conference about the shroud, the tests would entail infrared and ultraviolet photography as well as conventional black-and-white pictures. Other team members would make radiographic and x-ray fluorescence examinations, all to investigate the mechanical formation of the "negative" image on the cloth. The shroud had been stitched to a protective cloth backing, but the team would use a flexible optical instrument to examine the reverse side of the fragile fabric. Major business corporations, including photographic and electronic-equipment companies such as Polaroid, Kodak, and the Brooks Institute of Photography had agreed to lend or donate facilities and equipment for the tests. Lynn and Lorre expected to provide a quick-look report of their findings soon after the Turin exhibition. (*JPL Universe*, July 21/78, 1)

• The *JSC Roundup* printed a report by Dr. Thornton Page on his experiences during a friendship tour to China. Page, who had used the extreme-ultraviolet camera during Apollo missions, had asked for and received tours of Chinese astronomical facilities; in discussions with Chinese, Page learned most of their data were of western origin because of the limited quality and size of Chinese astronomical instruments. "They were delighted to have the books, reports, pamphlets, and photos I presented to them, particularly the NASA photos of Shuttle, Skylab in orbit, and ALSEP instruments deployed on the moon," Page reported. "They spoke about the large telescope under construction in Nanking, and their own telescope planned for a mountain site some 30mi northeast of Peking. Drs. Pan How-Ren and Wu Jian-Cheng are calibrating x-ray and far-UV detectors for use on a satellite, but they could not tell me when it will fly."

The Chinese told Page that a major change in national policy on science had taken place during the past yr, since the "Gang of Four" had been removed from power. Chairman Hua had given high priority to science and technology and had set a goal of doubling by 1982 the number of scientists and technicians in China. "None of the scientists I met," Page added, "was involved in teaching, and none of our other visits to universities and high schools in Manchuria or Shanghai revealed classroom instruction in these subjects." (*JSC Roundup*, July 21/78, 1)

July 24: NASA announced that mission controllers at ARC had completed final course adjustments for the *Pioneer 11* encounter with Saturn

Sept. 1, 1978. Controllers reported *Pioneer 11* had locked on a trajectory that would bring it within 30 000km (18 000mi) of the edge of Saturn's outer ring; any approach closer to the ring edge would risk impact with fragments in the ring. *Pioneer 11* would then swing under the plane of the rings to a point 25 000km (15 000mi) from the planet's surface. Without the course correction, *Pioneer 11* would have flown by Saturn at a much greater distance (100 000km or 60 000mi). Pioneer data transmitted to NASA tracking stations indicated the spacecraft had responded perfectly to a day-long series of commands calling for timed rocket thrusts to alter its trajectory. (NASA Release 78-113)

- NASA announced the ground breaking on a mountaintop near Boone, N.C., for the largest U.S. wind-turbine generator, scheduled for completion later in 1978. Using two 30m (100ft) steel rotor blades, the wind turbine would produce 2000kw of electric power in winds of about 39 to 69km (24 to 40mi) per hr, enough to meet the needs of about 500 homes in and around Boone, and would be the largest system field tested by a local utility under DOE's wind-systems development program managed by LeRC. General Electric Co. had been prime contractor for the Boone machine, which would be field-tested by the Blue Ridge Electrical Membership Corp. (NASA Release 78-105; DOE Release R-78-270)

- LaRC announced that Dr. Peter Calder, project director for the Olympus 593 engine at Rolls Royce Ltd., Bristol, England, would be guest speaker at a center colloquium July 31 on "Engine Options for Supersonic Cruise Aircraft." Calder would discuss the Olympus 593 twin-spool turbojet engine produced by Rolls Royce in Britain and SNECMA in France, which had powered the Concorde supersonic jet transport. He would describe development of the engine and its inlet, and discuss possible modifications to improve propulsion system operating efficiency and environmental acceptability. Concorde supersonic passenger service from Paris and London to South America and the Middle East had been under way for 2.5yr and to North America for 2yr, initially to Washington, D.C., and then to New York. (LaRC Release 78-38; *Langley Researcher,* July 28/78, 2)

- INTELSAT announced that it, together with the Federal Republic of Germany and Messerschmitt-Bolkow-Blohm (MBB), had funded development of a new high-efficiency solar-power collector. MBB had built the lightweight deployable solar array for use in satellites of the 1980s, with AEG Telefunken as subcontractor for solar cells on the array surface. ComSatCorp laboratories in Clarksburg, Md., had tested the array. Its weight, considerably less than that of current counterparts, would mean lower launch costs, and its higher power output would handle more onboard satellite electronics, enlarging its communications capacity. At the beginning of a 7yr mission, the new solar array would provide up to 38watts of power per kg of weight, a 300% increase over current models. Incorporating thin solar cells in the design might increase output to 50watts of power per kg of weight. (INTELSAT Release 78-22-I)

July 26: NASA announced that 16 astronaut candidates from JSC, including six female candidates, would undergo three days of training beginning July 31 at the Homestead Air Force water survival school in Fla. [See July 6.] More than half the 35 current candidates had had water survival training before entering the NASA program. Each day's activities would include classroom lectures on water-survival techniques and actual training in the water. The candidates, wearing a tethered parachute harness, would slide down a wire from a tower and be towed through the water in the harness to practice parachute release. In other exercises, candidates towed aloft under a parasail canopy would land in the water to be picked up by boat. On the final plunge from the parasail into the water, candidates wearing full survival gear would be picked up from their liferaft by helicopter. The Air Force's 3613th Combat Crew training squadron operated the water survival school. (NASA Release 78-114)

- NASA announced that effective July 30, the Legislative Affairs Division would become a separate organizational entity reporting to the Office of the Administrator. Experience over the past 8mo indicated that this change would better balance the workload of the senior staff and assure close and continuous liaison with the Legislative Branch. (NASA special anno July 26/78)

- MSFC announced it would issue a request for proposals (RFP) from industry to develop automatic welding for commercial use. Under NASA's requirement to transfer new technology to industry, it had decided to seek a new line of equipment for economical and more productive automatic welding of single and double contour welds. Automotive, shipbuilding, small watercraft, military hardware, aerospace, petroleum, and solar heating and cooling industries might use such an invention.

MSFC had built a prototype model with real-time computer-controlled weld speed and torch-angle control for making a variety of contour welds. The unit, equipped with digital closed-circuit television welding-torch guidance, could automatically maintain accurate alignment of the torch and weld joint during welding. Values for up to 5 constantly changing variables, measured and fed into the control computer to maintain constant speed and angle, could easily make contour corrections at every millimeter of travel or more frequently. The contract would call for development on a cost-sharing basis of commercial versions of the equipment for purchase and use by industry. MSFC's computer-weld skate with automatic torch guidance had three patents, two on the computer control and one on the closed-circuit television guidance; NASA had applied for an additional patent for the entire computer-weld skate. These patents could be licensed by the successful proposers. (*Marshall Star*, July 26/78, 4)

- The Dept. of Transportation announced it had issued an updated plan for development of an all-weather landing system that would eventually replace the current instrument-landing system worldwide. An FAA update of the original 1971 national plan had set forth requirements for completing the prototype phase of the program, on terms set by the International Civil Aviation Organization (ICAO) earlier in 1978. ICAO had selected the U.S./Australian time-reference scanning-beam microwave-landing system (MLS) to be the standard approach-and-landing guidance system of the future. The updated "National Plan for Development of the Microwave Landing System" called for completion of the prototype development and testing phase by the end of 1982. The plan made allowance for a transition phase between system development and implementation. Although it made no firm recommendations on implementation of the system, it described alternate strategies. Work had been completed on two of the six MLS configurations: a small-community airport version and a basic system for most commercial fields. Still to be developed were the "expanded" version for large hub airports and various tactical systems for military use.

DOT also had drafted a document for adoption by ICAO on Standards and Recommended Practices (SARPS) that would prescribe technical and operational characteristics of MLS to ensure quality of system performance and compatibility of air and ground components throughout the world. (FAA Release 63-78)

July 27: NASA announced it would launch on or about Aug. 7 from Cape Canaveral the second of two Pioneer spacecraft designed for direct measurement of Venus's dense searing atmosphere, making the 354 million km (220 million mi) flight to Venus on an Atlas Centaur rocket. Pioneer/Venus 2, 20da out from Venus, would separate into five atmospheric-entry craft. Four would enter Venus's atmosphere at points over the earth-facing hemisphere, two on the day side and two on the night side, and the fifth (the transporter bus) would enter on the day side. The Pioneer/Venus 2 entry probe would arrive five days after the Pioneer/Venus 1 orbiter.

The 30 experiments aboard the two Pioneers, a coordinated observational system, would employ the most spacecraft (6) ever devoted to one planet. NASA has designed the flights to study atmosphere and weather on another planet on a global scale as an aid to understanding the forces driving earth weather, and had issued a fact sheet (NASA Release 78-100) giving details on the surface, atmosphere, and stratosphere of Venus. (NASA Release 78-101)

- NASA announced that JPL engineers had commanded the shutdown of the *Viking 2* orbiter on July 25, when it ran out of attitude-control gas after circling Mars 706 times over the past 2 yr. Several mo previously, orbiter 2 had sprung a leak in one of its attitude-control jets; engineers had slowed the leak but could not stop it completely. *Viking 2*, launched Sept. 9, 1975, had traveled more than 643 735 000km (400 million mi) to reach Mars orbit Aug. 7, 1976. The *Viking 2* lander, riding piggyback on the orbiter, had landed Sept. 3, 1976, in the Utopia Planitia region of Mars's northern hemisphere. Plans called for the *Viking 1* orbiter and both Viking landers, functioning well almost 3yr after launch, to operate through Feb. 1979. The Viking project would continue through Sept. 1979 to allow scientists and engineers to process a backlog of data from the spacecraft and experiments. NASA had designed the orbiters to operate for 150da after planetary encounter and to orbit for at least 50yr, in hopes of avoiding planetary contamination before they disintegrated. (NASA Release 78-115)

- The *ARC Astrogram* reported that the quiet short-haul research aircraft (QSRA) built by Boeing under a contract from NASA had actually been a remanufactured twin-engine C-8A "Buffalo" airplane originally produced by de Havilland Aircraft of Canada, Ltd., that had been modified as an experimental aircraft to demonstrate technology for quiet short-haul commercial airliners of the future with short takeoff and landing capabilities.

The remodeled aircraft had made its first flight July 6 at Boeing Field, Seattle, Wash., strictly to test airworthiness and not for high-performance takeoffs or landings. A failure in the lateral stability-augmentation system (an automatic system to keep the plane stable during flight) had caused initial unsteadiness. The pilots had switched off the system and had flown the plane manually, correcting the motion problem. Pilot Tom Twiggs commented: "I didn't see any surprises. The QSRA simulation at Ames was one of the most accurate simulations I've flown. The failure modes we studied in the simulator saved the day in the first few moments of the flight." The plane had reached its maximum altitude of 6500ft and a speed of 120knots, maximum allowed by engineers for the first flight.

As of July 20 the plane had completed 10 flights with a total flight time of 13hr, and had accomplished all the objectives of the Boeing pre-ferry flight program except the noise tests. NASA would expect the QSRA at

ARC in early August. (*ARC Astrogram,* July 27/78, 1; *AvWk,* July 17/78, 21; *Aerospace,* Summer 78, 14)

July 28: NASA announced that a water pump and grain mill powered by solar cells, which had been installed in a remote Upper Volta village, would soon relieve the daily burdens of the villagers. Under a cooperative agreement between the U.S. Agency for International Development (AID) and NASA, AID would purchase all hardware including the solar-cell array, pump, and grinder; LeRC would provide manpower and technical management to design, fabricate, install, and monitor the system. The project would last about 1.5yr—several mo to set up the system and a yr for experimental operation, after which the villagers would run the system.

Dr. Louis Rosenblum, chief of the Solar and Electrochemistry Division at LeRC, said the solar-cell power system, after its completion in Dec. 1978, would be able to supply a peak 1.8kw of electricity; the water pump would be able to supply 4542 liters (1200 gal) of water per day. "The grinder will cut the time required to produce flour from 2hr to 10 minutes per family," he added. The cooperative project, part of an AID study of energy needs in food systems of less developed countries, would also address the socioeconomic effects of reducing the time needed by the women to grind grain and draw water. "There are more than three million villages without electric power in the world today," Dr. Rosenblum continued. "Success of the experiment in Upper Volta is bound to influence the direction taken by other developing countries to satisfy the pressing energy needs of their large rural populations." (NASA Release 78-111)

- LaRC reported the White House had issued a statement July 20, 1978, commemorating the ninth anniversary of man's first walk on the moon. The statement read in part: "Nine years ago today, the world paused to watch two brave men tread the surface of the moon. It was a moment without precedent in human experience, a moment when terrestrial life reached out to touch another world. It is a source of pride for us that those men were Americans. Today, the lunar surface is criss-crossed in a half dozen places with the footprints of American astronauts and implanted with a variety of American scientific instruments.

"The Space Shuttle, our next major manned space project, will begin regular, routine economical operation in the early 1980s. . . . In the deeper reaches of space, we will continue to seek to expand our knowledge of the solar system and the universe of which we are a part.

"As time and technology take us ever more deeply into the space age, it will continue to be our policy to conduct operations in space as required for our national well being and to support the right of all nations to do likewise. In so doing, we remain committed to the underlying principle of the exploration and use of space for peaceful purposes and for the benefit of all mankind." (*Langley Researcher*, July 28/78, 2; *Spaceport News*, July 21/78, 1; *JSC Roundup*, July 21/78, 4; *DFRC X-Press*, July 28/78, 4)

July 30: The *Washington Post* reported that two Soviet cosmonauts had set a new Soviet space walk record on July 29, spending 125min outside the *Salyut 6* space station testing a new type of suit and working with equipment mounted on the station, the accompanying *Progress 2* supply ship, and their own *Soyuz 29*. Cosmonauts Vladimir Kovalenok and Alexander Ivanchenkov were the fourth team of cosmonauts to successfully board the *Salyut 6* after it reached orbit the previous Sept. Kovalenok had filmed his colleague during part of the walk and had relayed the color footage to earth for broadcast on Moscow television.

Tass, the Soviet news agency, said the two cosmonauts had dismantled instruments and devices on the outer shell of *Salyut 6*, loading them into *Soyuz 29* for shipment to earth, and had mounted new instruments, including devices to measure radiation, on the Salyut. Instruments being returned had measured micrometeor activities and had aided research on "polymers, optical and other structural material used in building advance spacecraft," Tass said. The report did not give details on the new space suit, but the cosmonauts said that their "semistiff" clothes were well designed and that life-support systems had been improved to facilitate movement and "better fixation outside the station."

U.S. experts had interpreted the length of the Salyut mission and repeated trips to it by Soviet cosmonauts as indicating a focus by the Soviet space program on building permanent orbital platforms. The report had not indicated when the two cosmonauts would return to earth, but observers suggested that the next mission (*Soyuz 30*) would probably come soon and would be a marathon stay aboard the orbiting station. (*W Post*, July 30/78, D10; FBIS, Tass in English, July 29/78)

July 31: NASA announced that its scientists had been studying radar images of the North American coast from *SeaSat 1*, first ocean-monitoring satellite, launched in June 1978 and now in a 805km (500mi) high polar orbit. One of the satellite's five microwave sensors, a powerful radar system called a synthetic aperture radar (SAR), could take pictures of earth's surface day or night under any weather conditions. A typical SAR operation had produced a continuous swath of radar images 97km (60mi) wide by 4023km (2500mi) long, extending from the Mexican west coast to Alaska. JPL, manager of the SeaSat project, had processed the images. Scientists from NASA, NOAA, the Natl. Environmental Satellite Service, the U.S. Navy, and USGS had received images of the

Arctic pack, the Gulf Stream off the east coast of Fla., the Caribbean off the northern coast of South America, and a hurricane zone near the Baja Calif. peninsula. (NASA Release 78-116)

- ESA announced that its *Geos 2* scientific satellite launched from Cape Canaveral July 14 on a Delta and placed in geosynchronous orbit, had reached its scheduled position of 6°E on July 26. It would move during its 2-yr mission from its first operational station in geosynchronous orbit 35 900km above the equator through a zone extending from 0° to 37°E longitude. On July 26 the European Space Operations Centre at Darmstadt, West Germany, had switched on the S-band telemetry system and the magnetometer experiment, and would switch on six other experiments progressively until the satellite had become fully operational in early Aug. All data confirmed that *Geos 2* was functioning correctly. The satellite, positioned on magnetic field lines linked to the earth's auroral zones, could correlate those data with similar data acquired from associated auroral stations by ground-based balloon-borne or rocket-borne instruments. NASA had expected that the *Geos 2* data, correlated with data acquired by the already launched *Isee A* and *B* and by the ISEE-C scheduled for launch in Aug. 1978, would constitute a substantial body of information on the magnetosphere to aid in understanding the effect of interplanetary-space processes on the near-earth environment. (ESA Release July [illegible]/78)

During July: The USAF announced it had launched a second prototype satellite in DOD's NavStar global-positioning system from SAMTEC facilities aboard an Atlas F booster. The 955-lb navigational satellite working with a previously orbited NavStar satellite would be part of the program's concept-validation phase using six satellites to test navigation capability at the Army's Yuma, Ariz., proving grounds. When fully operational in the 1980s, the 24-satellite NavStar system would provide precise worldwide navigation coverage 24hr a day. The Air Force's global-satellite control network, managed by SAMSO's Air Force Satellite Control Facility at Sunnyvale, AFS, Calif., would track and operate the satellite. (AFSC *Newsreview*, July 78, 12)

The USAF announced it had launched a third defense meteorological satellite from SAMTEC facilities at Vandenberg AFB on a Thor LV-2F into a near-polar sun-synchronous orbit 450mi above the earth. The 1131-lb satellite carrying visual and infrared instruments had joined two previously orbited spacecraft in providing high-priority weather forecasts to U.S. military commanders worldwide. The sensors could detect and observe developing weather patterns and could track existing weather systems over remote areas, including oceans.

After 30 days of on-orbit tests, the satellite was orbiting the earth every

101min, scanning a 1841-mi area on each pass and photographing the entire earth over a 12-hr period. It would transmit weather imagery in real time to ground and shipborne terminals around the world for military purposes and, through NOAA, to the civilian community. (AFSC *Newsreview*, July 78, 1)

- NASA announced that President Jimmy Carter had presented 1977 presidential management-improvement awards to Curtis Helms and Thomas Winstead of MSFC's structures and propulsion laboratory. The two were among 7 awardees, selected from 50 nominees, honored at a May 23 ceremony in the White House rose garden. Their redesign of the Space Shuttle external fuel tank, eliminating one of the two vent-relief valves, had reduced vehicle weight and program costs while still meeting venting requirements and reliability standards, resulting in total savings of $5.6 million. (*NASA Actv.*, July 78, 27)

- NASA announced it had made several personnel changes. Richard Smith, deputy director at MSFC, had been appointed deputy associate administrator for Space Transportation Systems at NASA Hq for a one-yr tour of duty beginning August 15. Smith had transferred to NASA in 1960 from the rocket research and development team at the Army's Redstone Arsenal, when the development operations division of the Army Ballistic Missile Agency had become the nucleus of MSFC. He had managed the Saturn program, and in January 1974 had become director of science and engineering, and later deputy director, of the center. Smith had received NASA's exceptional service medal for contributions to the Apollo and Skylab programs as well as the medal for distinguished service. (NASA Release 78-112; NASA anno July 19/78)

NASA had named Harry Sonnemann deputy chief engineer at Hq, responsible to the chief engineer for managing program assurance, safety and environmental health, and the systems engineering divisions. Sonnemann had come to NASA in October 1977 from the office of the assistant secretary of the Navy, where he was special assistant for electronics and special assistant for antisubmarine warfare and ocean control from 1968 to 1977. He had also worked on the development of large seismic arrays as assistant director for field engineering in DOD's Advanced Research Projects Agency's nuclear test detection office from 1964 to 1968. (NASA anno July 20/78)

Scientist-astronaut Dr. Joseph Allen had returned to active flight status at JSC's astronaut office. From August 1, 1975, until his return to JSC, Allen had been director of the office of legislative affairs at NASA Hq; and he would continue those duties in addition to his astronaut duties until a replacement was named. He had returned to JSC as senior scientist-astronaut and was eligible for selection as a Space Shuttle crewman. NASA had selected Allen as a scientist-astronaut in 1967; he had completed the initial academic training and a 53-wk course in flight training at Vance AFB, Okla. Allen had been mission scientist as a member of the astronaut-support crew for *Apollo 15*, and was staff consultant on science and technology to the President's Council on International Economic Policy. (NASA Release 78-33)

NASA announced it had appointed Dr. Edward Ifft chief of international programs policy at Hq. Dr. Ifft had been a U.S. Foreign Service reserve officer, whose last assignment was director of the State Department's office of disarmament and arms control. While a graduate student, Ifft spent a yr at Moscow State Univ. under a U.S.-USSR cultural exchange program doing research on low-temperature physics. He had joined the U.S. Arms Control and Disarmament Agency in 1967; then moved to the State Department where he had been deputy chairman of the U.S. delegation that negotiated the threshold test-ban treaty in Moscow in 1974; and had participated in negotiations with the U.S. and USSR for a comprehensive test ban. (*NASA Actv*, July 78)

- The USAF announced that its ESD Spacetrack System Office had awarded Bunker Ramo Corp. of Westlake Village, Calif., a $927 000 contract for equipment to record and store data for military and authorized scientific use on all man-made objects orbiting the earth. The system would record information received at the Space Computational Center in NORAD's Cheyenne Mountain Complex, Colo., on positions of the thousands of satellites and other man-made objects in space, and would store the data for 3yr in the computer's active file. It would also microfilm historical data for permanent storage. The new system had become necessary because the automatic data-processing equipment formerly used by the Aerospace Defense Command lacked permanent-storage capability and was very expensive to maintain. (AFSC *Newsreview*, July 78, 6)

August

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August 1: NASA announced that Chimex Systems, Inc., of Houston, Tex., had received a subcontract from Computer Sciences Corp. of Falls Church, Va, for institutional computer systems engineering, development, and production operations under CSC's 5-yr contract with Johnson Space Center. A major factor of CSC's winning bid had been its plan to use minority subcontractors. This was the fourth NASA contract won by Chimex, which had provided keypunch services at Kennedy Space Center and engineering support and keypunch services at JSC. Under the new subcontract, Chimex would employ 40 people primarily in keypunch and data-distribution at an estimated $800 000 per yr for 5yr. NASA's minority business awards for the first half of FY1978 had amounted to more than $37 million. (NASA Release 78-117)

August 2: NASA announced it had turned over *Goes 3*, third in a series of geostationary operational environmental satellites, to NOAA for operation on July 5, 1978, at 1600Z. Since its launch on June 16, NASA engineers, wishing to ensure proper operation, had completed an orbital checkout in 14da, rather than the 30da required for previous GOES missions. Goddard Space Flight Center's newly installed GOES test laboratory had accelerated the schedule by allowing full-time communications with *Goes 3*; NOAA's Wallops Island facilities had been available to previous missions only part-time. Engineers had checked out *Goes 3* during its westward drift at 2 deg/day toward its operational station at 135°W, and had corrected the orbit inclination from 1.7° to the specified 1°.

First pictures from the satellite's visible and infrared spin scan radiometer (VISSR), received June 29, were of excellent quality. More than 52lb of the initial 80lb load of hydrazine was available, enough for more than 5yr of normal operations. A minor problem with the spacecraft data-handling equipment that relayed signals from earth-based data-collection platforms had resulted from interference by VHF equipment that could be turned off during most of the mission. The GOES laboratory would monitor operating data to detect any variables in performance with time and temperatures.

NASA had advised NOAA that, based on preliminary analyses, the spacecraft was operating under no constraints. According to NOAA's plan for final positioning, *Goes 3* would replace *Goes 1* at 135°W longitude; *Goes 1*, relocated over the Indian Ocean, would support the

PAGE 180 INTENTIONALLY BLANK

first GARP global experiment. (NASA MOR E-612-78-01 [postlaunch] Aug 2/78)

• Marshall Space Flight Center announced that its test engineers had successfully completed the first series of live firing tests of the Space Shuttle's main propulsion system, with all major test objectives achieved. Rockwell Intl.'s Space Systems Group had conducted the test program for MSFC. The test version of the propulsion system had consisted of three Shuttle main engines mounted on an orbiter aft fuselage with a flight-type external propellant tank and associated systems. The first series of tests (Apr. 21, May 19, June 15, and July 7, 1978) had recorded systems operation at thrust levels from 70 to 90% of rated power for up to 100 sec; in the final test, engines were throttled down from 90% thrust to 70% and back up to 90%. The Shuttle would be the first spacecraft with throttleable engines.

After removal from the test stand at the National Space Technology Laboratories, the engines had undergone modifications for more firings later in 1978. The next test series would run the engine at rated power levels (357 000lb, or 1.67 million newtons at sea level) for more than the 500sec required to lift the Shuttle into orbit. Results of the tests would verify main propulsion system operation before the first manned orbital flight, scheduled for 1979. (*Marshall Star*, Aug 2/78, 1)

• Work on the dynamics test stand had begun in preparation for the next series of Space Shuttle mated vertical ground-vibration tests, the *Marshall Star* reported. After changing the configuration inside the stand from a "hanging" to a "sitting" arrangement, MSFC engineers would adjust the platform to fit the vehicle assembly. For the first series of tests, the orbiter and external tank had been suspended from airbags on a truss structure high in the stand, to simulate the Shuttle after the solid-fuel rocket booster had separated and before external-tank jettison. The next series would test the ET, orbiter, and SRBs mated in the liftoff configuration; the SRBs would sit on a hydrodynamic support system to which the ET and orbiter had been attached. (*Marshall Star*, Aug 2/78, 1)

• GSFC reported that faint radio signals from 10 million billion miles away had given astronomers the first proof of the long suspected presence of methane (natural gas) outside the solar system. GSFC scientists had detected methane in three locations in deep space: in the Orion A gas cloud, and in gas clouds surrounding variable star RX Boo and carbon star IRC-plus-10216. "The discovery of methane outside our solar system could have an important role in determining the abundance of carbon in the universe," noted Dr. Kenneth Fox. Methane previously had been detected only on earth, Jupiter, Saturn, and its moon Titan, Neptune, and Uranus.

The discovery had confirmed that interstellar space was not devoid of complicated molecules; at least 40 types of molecules had been discovered suspended in space, and the findings were important to scientists attempting to construct models of the origin of the universe. Dr. Fox and Dr. Donald Jennings had searched for the emissions for 3yr using radiotelescopes at the Natl. Radio Astronomy Observatory at Greenbank, W. Va., Kitt Peak near Tucson, Ariz., and the Haystack observatory in Westford, Mass. "Methane now appears to be one of the most abundant molecules in Orion A, perhaps second only to hydrogen [the most abundant gas in the cosmos]," Fox said. Fox and Jennings planned to map the source of methane in Orion A for its precise location and any associations with stars or stellar objects. (*Goddard News*, Aug 2/78, 2)

- *Aerospace Daily* reported that the Senate Appropriations Committee had approved a FY79 $4.359 billion funding bill for NASA, restoring $20.5 million cut by the House-passed companion bill for development of the teleoperator retrieval system (TRS) that NASA wanted to use to reboost or deorbit Skylab. Although the full committee had not changed the NASA funding approved earlier by Sen. William Proxmire's subcommittee, Proxmire indicated that when the omnibus bill reached the Senate floor, he would move to cut all its appropriations, including NASA's, by 2%. The Appropriations Committee also approved a second FY78 supplemental funding bill that included $58.7 million to acquire the Navy's fourth and fifth Fleet Satellite Communications (FltSatCom) spacecraft, as recommended earlier by the defense subcommittee. (*A/D*, Aug 2/78, 138)

August 3: NASA announced it had selected astronauts Dr. Owen Garriott and Dr. Robert Parker to be mission specialists on Spacelab 1, scheduled for launch in the early 1980s. Mission specialists would be responsible for coordinating Shuttle operations with the commander and pilot in crew-activity planning, consumables usage, and Space Transportation Systems/payload interaction. The 7-day flight, a verification test of Spacelab systems and Spacelab/orbiter interfaces, would carry about 40 experiments. Garriott had flown on the second manned Skylab mission of 56da duration; Parker had been a mission scientist and spacecraft communicator during Apollo and Skylab.

Ten European nations, under agreements with the European Space Agency, had developed and financed Spacelab to be carried in the cargo bay of the Space Shuttle orbiter as a fully furnished laboratory adapted to the weightless environment of space and pressurized for working without space suits. Spacelab 1 would also carry two payload specialists (one European and one U.S. citizen) to operate the scientific instruments. (NASA Release 78-121; JSC Release 78-34; *JSC Roundup*, Aug 4/78, 1; *Marshall Star*, Aug 16/78, 3; *DSFC X-Press*, Aug 11/78, 3; *Langley Researcher*, Aug 11/78, 1)

- NASA announced it had selected four American scientists as payload specialists for the second Spacelab mission scheduled for 1981. Those named were Dr. Loren Acton of Palo Alto, Calif., research scientist at Lockheed's Palo Alto research laboratory; Dr. John-David Bartoe of Reston, Va., and Dr. Dianne Prinz of Alexandria, Va., both research physicists at the U.S. Naval Research Laboratory; and Dr. George Simon of Alamagordo, N.M., chief of the solar-research branch at the Air Force Geophysics Laboratory. Two of these scientists would be selected to fly on the orbiting space laboratory to operate the scientific experiments; the others would operate ground-based experiment equipment and assist the two in orbit. The Spacelab investigators' working group (IWG), composed of Spacelab 2 principal investigators having experiments on the mission, had selected the payload specialists, each of whom was a coinvestigator on one of the Spacelab 2 experiments.

Scientific investigations on Spacelab 2 would be mainly in astronomy, high-energy astrophysics, and solar-physics research, with others in plasma physics, botany, medicine, and space technology. Scientific instruments on the mission would be "pallet only," exposed to space in the orbiter's cargo bay. Payload specialists would operate their experiment equipment from the orbiter's crew cabin, working in shifts to run the experiments 24hr a day. The mission, scheduled for launch from KSC in 1981, would orbit at an altitude of about 450km (250mi) for 9da. MSFC had been responsible for payload specialist training as part of its overall management responsibility for the Spacelab mission. (NASA Release 78-120; *Marshall Star*, Aug 9/78, 1)

August 4: MSFC announced it had awarded Lockheed Missiles and Space Co., Sunnyvale, Calif., a $2.7 million contract to develop and deliver a flight experiment solar-array wing by May 1980 for a Shuttle orbital-flight test in November 1980. A significant step toward producing large amounts of power in space, the experiment would verify structural and dynamic characteristics of the solar-array wing, its electrical performance, and the readiness of solar-array technology for planetary- and earth-orbit Space Shuttle payload applications.

The solar-array wing, 32m (105ft) long and 4m (13.5ft) wide, folded and stored in the Space Shuttle's cargo bay during launch, would be extended to its full length and retracted several times during the test. When its solar-cell surface was fully extended, the array's 82 panels would convert solar energy to produce 12.5kw of power. Only three of the panels would be active in the experiment flight. The experimental solar-array wing would demonstrate that use of this technology to augment power for Shuttle and Spacelab could extend mission duration and lead to a solar-electric propulsion stage. Solar-array technology could have Shuttle-payload applications such as space-base construction, satellite power systems, and power modules. NASA's Office of Aeronautics and Space Technology had directed the solar-array program as part of a larger effort on solar-electric propulsion for long-term missions in the mid-1980s. (NASA Release 78-123; *Marshall Star*, Aug 9/78, 1; *DSFC X-Press,* Aug 11/78, 4; *A/D,* Aug 4/78, 151; *AvWk,* Aug 14/78, 15)

- Lewis Research Center announced that NASA Hq had joined with the FAA in sponsoring a 3-day aircraft-icing workshop at LeRC. Attended by more than 100 icing specialists, sensor/instrument specialists, meteorologists, and weather forecasters, the workshop had assessed fixed-wing and rotocraft operational icing, evaluated facilities requirements for R&D and certification, examined ways to improve icing forecasts, and identified gaps in knowledge of aeronautical icing. LeRC had been chosen for the conference because its research on icing in the 1940s and 1950s was still important in aircraft certification; it also had the largest icing-study facility currently actively operating in North America. As a result of needs defined at the workshop, LeRC would begin a new program of research on icing. (*Lewis News*, Aug 4/78, 2)

- NASA reported that the Natl. Business Aircraft Association at its annual convention in St. Louis Sept. 13 would present to Dr. Richard Whitcomb, aeronautical scientist at Langley Research Center, its Meritorious Service to Aviation Award for 1978. Whitcomb would be honored for "significant contributions to the field of aviation." Among those contributions were the area-rule design (a "Coke bottle" airplane shape that reduced drag and increased aircraft speed without the need for additional power, incorporated in every U.S. supersonic airplane now flying); and the "supercritical" wing developed during the 1960s to increase the speed and range of subsonic aircraft without an increase in required power or fuel consumption. Whitcomb had begun his career in 1943 with the National Advisory Committee for Aeronautics (NACA), NASA's predecessor, and was head of LaRC's Transonic Aerodynamics Branch. (NASA Release 78-119)

August 7: *Av Wk* reported that the Defense Dept.'s high-energy laser program had been encouraged by a demonstration earlier in 1978 of the use of laser radiation to destroy a high-speed antitank missile in flight. The test, using a chemical laser built by TRW Systems under sponsorship of the Navy and the Defense Advanced Research Projects Agency (DARPA), occurred at a TRW facility in southern Calif. near San Juan

Capistrano; Hughes Aircraft Co. had supplied the laser-beam pointing/target-tracking system.

DOD officials cautioned that, despite encouraging progress, high-energy lasers would not begin to replace conventional weapons, at least in the near future, because the Pentagon could not consider working on a high-energy laser-weapon system before FY82, and that date could slip. The most probable near-term application would be close-in air defense for large ships such as aircraft carriers, whose value would justify the cost of a laser-radiation weapon. Another potential near-term application would be mobile short-range air defense of high-value Army targets (known as the high-energy laser-tactical defense system). If the Pentagon decided to develop a laser-radiation weapon system, it would be only one in a mix of air-defense weapons, because of what appeared to be intrinsic range and weather limitations of lasers. (*AvWk*, Aug 7/78, 14)

August 8: NASA announced that data returned by the American-British-European international ultraviolet explorer (IUE) satellite had suggested the existence of a massive black hole at the center of globular clusters in earth's galaxy. A group of scientists headed by Dr. Herbert Gursky and Dr. Andrea Dupree, both of the Harvard-Smithsonian Center for Astrophysics, Cambridge, Mass., had examined six clusters, three of them x-ray sources.

NASA, in cooperation with ESA and the British Science Research Council, had launched IUE in Jan. 1978 into a modified near-equatorial synchronous orbit to study a wide range of celestial objects in the ultraviolet region of the electromagnetic spectrum. Dr. Gursky said the onboard UV instruments had delivered unexpected information when they penetrated the background denseness of the clusters, which were like miniature galaxies 15 000 light-yr away, to observe the cluster core. What they saw, according to Gursky, was probably radiation from a group of 10 to 20 bright-blue stars orbiting the core: "These stars may well be orbiting a massive black hole the size or mass of one thousand solar systems," he said. However, existence of a black hole was not certain, as rotation of the stars in relation to the center of the million-star cluster had to be studied first. If the stars were indeed orbiting a massive black hole, Gursky believed they were right on the edge or, if not, might be providing their own gravitational equilibrium.

What surprised the observation team, Gursky said, was the ability of the short-wavelength instrumentation to cut clearly through the million-star cluster. "For the first time we are seeing in a clean way the center or core of those globular clusters, and we were surprised. You can see the clusters in visible light, there are lots of red giant stars there, which mask what is going on in the center. Now we have a tool, the IUE's shortwave ultraviolet, capable of going for the first time right to the core through the whole cluster," said Gursky. Although the team would continue to observe the six globular clusters, Gursky doubted their findings could be definite until NASA put the space telescope in orbit from the Space Shuttle in 1983. That telescope, using much more powerful instrumentation including short-wavelength ultraviolet, could study the blue stars in more detail. (NASA Release 78-122)

- In a report on Soviet space activities, *Defense/Space Business Daily* said *Progress 2* had crashed into the Pacific Aug. 4, 2da after it had undocked from the Salyut station where it had been for 25da. This Progress resupply spacecraft (a modified Soyuz) had not been designed as a recoverable reentry and descent vehicle.

The Soviets had orbited *Cosmos 1028*, believed to be another in a series of long-duration high-resolution reconnaissance/surveillance satellites; orbit was 182/272km, 67.1° inclination, 88.7min period. Another in the series, *Cosmos 905*, launched Apr. 26, 1977, had remained in orbit 30da and was recovered. Others in the series had been *Cosmos 758*, in orbit for 20da after launch Sept. 5, 1975; *Cosmos 805*, in orbit for 20da after launch Feb. 20, 1976; and *Cosmos 844*, in orbit 39da after launch July 22, 1976. (*D/SD*, Aug 8/78, 171)

August 9: NASA announced that *Landsat 3*, an earth-monitoring satellite equipped to measure earth's emitted and reflected radiance, had suffered a failure in its fifth (or thermal infrared) band. Launched Mar. 5 into a near-circular 917km (570mi) high polar orbit, *Landsat 3* had returned excellent imagery from its other four bands. NASA engineers believed the thermal-sensor problem had resulted from moisture buildup on a glass screen through which the instrument viewed earth. Efforts to correct the situation had been unsuccessful, and NASA had convened a special review board to examine the problem.

Scientists had hoped to use *Landsat 3*'s thermal data to detect crop stress and to recognize "heat islands" associated with urban and industrial development. However, NASA's heat-capacity mapping mission (HCMM), launched in Apr. into an orbit more favorable to thermal-infrared data collection, had been returning excellent day-night data that could serve that purpose. (NASA Release 78-124; *D/SD*, Aug 14/78, 203; *A/D*, Aug 23/78, 236)

- JSC and the U.S. Geological Survey jointly announced that the Survey had published a surface-fault map of the southeastern greater Houston area. JSC geologist Uel Clanton and Earl Verbeek of the USGS had created the map covering about 200 sq mi to evaluate the magnitude of faulting in metropolitan Houston. The map had displayed 91 faults with a total length of 110 mi, cutting through residential and commercial areas in many cities. Faulting was extensive east and southwest of Hobby Airport and in the Mykawa oil field in both northwesterly and northeasterly directions. The mapmakers had used a combination of aerial photography and ground-level confirmation of faults. (JSC Release 78-35; *JSC Roundup*, Aug 18/78, 1)

- Payload specialist candidates had begun training at MSFC for the late-1980 first Spacelab mission, the *Marshall Star* reported. The first 5-day session had covered training approach and plans. Trainees were Michael Lampton of the Univ. of Calif., Berkeley; Byron Lichtenberg of the Mass. Inst. of Technology; Ulf Merbold of W. Germany's Max-Planck Inst.; Claude Nicollier, a Swiss, from the European Space Technology Center; and Wubbo Ockels of Groenigen Univ. in the Netherlands. One American and one European would fly on the mission; the others would assist on the ground. Later in the training cycle, NASA would select those to fly. (*Marshall Star*, Aug 9/78, 2)

- The Senate had cut $5 million from NASA's $3.87 billion R&D budget for FY79 before passing a package appropriations bill that included the agency, *Aerospace Daily* reported. The Senate had first rejected by 44-43, then accepted by 45-42, an amendment offered by Sen. William Proxmire (D-Wis.) to cut NASA's budget and reduce budgets of five other departments and agencies by $805 million. Proxmire's move might have spared NASA a far deeper cut, because Sen. William Roth (R-Del.) had proposed a 2% across-the-board cut for all agencies and departments covered by the bill (which, for NASA, would have been $80 million). Proxmire had offered his more selective amendment as a substitute, to which Roth had agreed. The amendment did not specify where NASA should cut its R&D. (*A/D*, Aug 9/78, 169)

August 10: NASA announced that the first major symposium on crop monitoring based on space-age technology, scheduled for JSC Oct. 23-26, would discuss results of the Large-Area Crop-Inventory Experiment (LACIE). The symposium would give participants from government, industry-agriculture, and university communities around the world more information about LACIE's pioneering effort and how it could best be used to improve the world food situation. LACIE, a 3yr program of NASA and the U.S. Department of Agriculture working with university and industrial research groups, had been designed to estimate wheat production in major growing areas throughout the world by using satellite data and the global weather-observation network. LACIE had begun in the fall of 1974 when DOA had recognized a need for information on wheat-growing areas outside the U.S. Landsat satellites continuously scanning agricultural regions had provided the electronic imagery for area estimates. Combined daily with ground-acquired data and information received from 8000 worldwide weather stations, the imagery had made it possible to predict crop area, yield, and production of domestic and foreign wheat-growing regions and to give an early warning of problems.

Earth resources scientists had learned to identify the "signature" (appearance) of wheat in the satellite data; others had been able to estimate the growth stage and potential yield of wheat. Computer programs combining records of weather conditions in past growing seasons with figures on crop yields in the past had enabled experimenters to estimate yields for the current growing season. Results from LACIE had shown the effectiveness of new technology in improving knowledge of global wheat production generally applicable to other crops. USDA was considering use of the data source to give early warning of significant changes in prospects for global commodity production. (NASA Release 78-125)

• LaRC announced it had awarded two computer contracts: one to the Charles Stark Draper Laboratory, Inc., Cambridge, Mass., for an engineering model of a fault-tolerant multiprocessor (FTMP) computer. Draper Laboratory, which had designed the FTMP computer under a previous NASA contract, had intended it for safety-critical avionic and flight-control systems on future civil-transport aircraft. The FTMP could start and operate several aircraft functions (flight control, autopilot, navigation and guidance, and display and master alarms) without manual intervention and could also assess flight procedures including takeoff, climb, cruise, descent, and landing. The 2.5-yr contract would cost about $1.8 million.

The second contract award was to SRI International, Menlo Park, Calif., for an engineering model of a software-implemented fault-tolerant (SIFT) computer. Conceived by SRI under a previous NASA contract, SIFT would perform the same functions as FTMP. SRI would work under the $1.6-million 2-yr contract in Menlo Park and at a subcontractor facility in Teterboro, N.J. LaRC would manage both contracts. (LaRC Release 78-42)

• The USAF had budgeted $664 million for space procurement in FY80, up from $379.6 million in FY79, *Defense/Space Business Daily* reported. Major increases were in the defense support program (early-warning satellite by TRW and Aeroject), up $48 million; the satellite data system (Hughes), up $80 million; the defense satellite-communications systems (DSCS), up $65 million; and the Space Shuttle (Rockwell Intl.), up $73 million. The USAF had planned to buy five satellite systems in FY80: an RCA defense meteorological satellite program (DMSP) spacecraft; a defense support program spacecraft; a satellite data system spacecraft; and two DSCS spacecraft. One spacecraft to be purchased in FY79 would be a DMSP. The Air Force had last purchased boosters (three

Martin Marietta Titan IIIs) in FY78 and planned none for FY79 or 80, "assuming Shuttle stays on schedule," a USAF official said. (*D/SBD,* Aug 10/78, 188)

August 14: NASA announced it had flown its quiet short-haul research aircraft (QSRA) to Ames Research Center to begin a flight-research program on design and operation of future quiet short-haul transport. The QSRA [see July 27] had been the first to achieve truly quiet operation of jet aircraft, through high-performance special treatment of the engines and nacelles to restrict landing and takeoff noise to relatively small areas. Operating less noisily than most small private aircraft, the 4-jet QSRA had a 90-decibel noise-impact area, smaller than 1.3km^2 (0.5mi^2). Scaled up to the equivalent of a 150-passenger aircraft, the 90-decibel noise-impact area would be less than 2.6km^2 (1mi^2), compared to the approximately 78km^2 (30mi^2) noise impact of comparable-size aircraft.

High performance of the QSRA resulted from a design concept in which four jet engines mounted on top of the wing directed fan air from the engines across the upper surface of the wing and flaps, significantly increasing lift, particularly at lower speeds. Compressed air from the engines, fed through an ejector system, provided boundary-layer control-blowing at the wing leading edges and ailerons, further enhancing lift and control. Future QSRA-derivative aircraft the size of the Boeing 727 transport could carry the same payload at the same speeds but could operate from small airports with short runways (about 1/2 to 1km [1500 to 3000ft], compared to current requirements for lengths of 1.6km [1mi] or more) and could operate without disturbing surrounding communities. (NASA Release 78-126; *DSFC X-Press,* Aug 11/78, 2; *AvWk,* Aug 14/78, 20)

- NASA announced that Dr. Lo I. Yin, a scientist at GSFC, had demonstrated his invention of a hand-held x-ray device at the annual convention of the National Medical Association in Washington, D.C. The Lixiscope (low-intensity x-ray imaging scope), a gun-shaped instrument weighing about 0.67kg (1.25lb), was powered by a single penlight 2.7v battery and a small radioactive source. Although Dr. Yin had not claimed his invention could replace x-ray equipment, he saw its value in mobility—in military situations or sports, for example. Dr. Yin had done this work under NASA's technology utilization program, aimed at identifying and transferring aerospace technology benefits to the general public. NASA had patented the Lixiscope, and the license would be available at no cost. (NASA Release 78-127)

GSFC reported that 100 representatives from U.S. industry and research institutions had met there to discuss possible applications of the Lixiscope, which had originated out of a need for single-photon imaging in x-ray astronomy. The sensitivity of the Lixiscope was so great that it could significantly reduce the dose of radiation received by a patient. Pulling a trigger on the device would unshield the radioactive source and send into the object being examined a low dosage of x-rays to be absorbed by a phosphor screen that would convert them to visible light. Six companies had applied for a license to manufacture or distribute the Lixiscope, not yet commercially available. NASA had estimated the cost of a mass-produced instrument composed entirely of existing technical components at about $5000. NASA was considering use of the device on the Space Shuttle. (*Goddard News*, Aug 16/78, 1)

August 15: Dr. Christopher Kraft, Jr., JSC director, had invited 31 former astronauts to take part in technical briefings and updates on the status of NASA programs at JSC Aug. 21-22, NASA announced. NASA Administrator Dr. Robert Frosch would address the group; John Yardley, associate administrator for Space Transportation Systems, would review the Shuttle program. Others giving briefings would be Robert Thompson, manager of the Space Shuttle program; Aaron Cohen, manager of the Orbiter project; Glynn Lunney, manager of the Shuttle payload integration and development program; Lt. Gen. Thomas Stafford, former astronaut now deputy chief of staff for research, development, and acquisition, on the USAF Shuttle program; John Young, chief of the astronaut office; and flight crews of the orbiter approach and landing tests (ALT). Those attending would take conducted tours of the crew systems area, remote manipulator system, full-scale orbiter mockup, and the orbiter aeroflight simulator/Shuttle mission simulator.

Astronauts invited were Edwin Aldrin, Jr.; William Anders; Neil Armstrong; Frank Borman; M. Scott Carpenter; Gerald Carr; Eugene Cernan; Michael Collins; Charles Conrad, Jr.; L. Gordon Cooper; Walter Cunningham; Charles Duke, Jr.; Donn Eisele; Anthony England; Ronald Evans; John Glenn; Richard Gordon, Jr.; James Irwin; James Lovell, Jr.; James McDivitt; Edgar Mitchell; William Pogue; Stuart Roosa; Walter Schirra, Jr.; Harrison Schmitt; Russell Schweickart; David Scott; Alan Shepard, Jr.; Thomas Stafford; John Swigert, Jr.; and Alfred Worden. (NASA Release 78-128; JSC Release 78-37)

August 16: GSFC reported that two Voyager spacecraft heading for Jupiter had discovered low-frequency radio waves naturally emitted from the planet behaving in a manner directly opposite to that of its high-frequency emissions. The Voyagers, now slightly more than halfway to their 1979 Jupiter encounter, had looked back at the earth for new clues to the origin of natural low-frequency radio waves flooding into space from earth. "The polarization plane of the low- and of the high-frequency radio waves from Jupiter seems to be exactly opposite," said Joseph Alexander, one of a team of GSFC scientists working on Voyager experiments. Observers could distinguish the source of the waves from the polarization plane (within which radio waves vibrated as they traveled through space) according to whether it varied randomly, systematically rotated clockwise or counterclockwise, or stayed constant. The Voyager spacecraft had permitted first-time measurement of the polarization plane of low-frequency radio waves, because the earth's ionosphere had heretofore shielded the waves from ground telescopes. Scientists for years had observed the high-frequency waves, not similarly blocked.

The GSFC team called the new data from Jupiter more puzzling than enlightening, with no explanation of why the waves differed so radically. One theory was that the two kinds of waves originated from entirely different kinds of processes in Jupiter's atmosphere; another theory suggested the same emission mechanism for both, with waves generated from Jupiter's southern hemisphere rotating clockwise at low frequency and those from the northern hemisphere turning counterclockwise at high frequency. As the Voyagers moved closer to Jupiter, the team hoped to find new clues by studying the planet's response to the solar wind. (*Goddard News,* Aug 16/78, 1)

- GSFC reported that several Goddard-controlled satellites had observed the largest solar flare in recorded history July 11. The observations had furnished a new data base for scientists investigating the causes of solar flares and how they affected the earth. Explosions of solar flares on the sun's surface had generated huge shock waves in the solar wind (ionized particles flowing at supersonic speeds over the earth and other planets) and had blasted into it new free-flying highly energetic particles that disorganized interplanetary magnetic fields. The flare had disrupted earth's ionosphere and had blacked out shortwave radio communications for 2hr throughout the entire sunlit hemisphere.

Two interplanetary monitoring platforms (IMPs) orbiting the earth had recorded the interplanetary magnetic field disturbances and the intensification of particle flow from the sun. *Helios 1*, a sun-orbiting satellite observing the sun from the opposite side of the earth July 11, had recorded changes in and composition of the radio noise, plasma, magnetic fields, and energetic particles streaming from the sun. The flare had saturated the high-sensitivity detectors on orbiting solar observatory *OSO 8*, which had previously obtained data on smaller flares associated with the large-flare region. *Atmosphere Explorer C* had noted atmospheric heating from solar-wind particles deposited on the earth at high latitudes. The international sun-earth explorers A and B *(Isee 1* and *2*) had obtained data on the accompanying magnetic fields and energetic particles, and *Applications Technology Satellite 6* had recorded data on tions for nuclear plants, pipelines, and offshore facilities; and needs associated with product liability. These challenges had stimulated new developments; as an example, Berger would discuss radiography, including real-time methods, image enhancement, and unusual radiation techniques using neutrons and protons. (LaRC Release 78-83)

• The *Marshall Star* announced that the most extensive study ever made of Venus had begun with the arrival at the planet of *Pioneer Venus 1*, the orbiter half of the two-spacecraft Pioneer Venus mission. It went into orbit Dec. 4 and was scheduled to take pictures and make measurements for one Venusian yr (225 earth days) or more. On Dec. 9, the four probes and transporter bus of *Pioneer Venus 2* would plunge into the Venusian clouds at widely separated points to measure the dense atmosphere in detail from top to bottom. A spokesman at Ames Research Center, manager of the project for NASA's Office of Space Science, reported Dec. 4 that *Pioneer Venus 2* was on course and on schedule. (*Marshall Star*, Dec 6/78, 2)

• On Dec. 12, the U.S. Coast Guard would receive its first lightweight portable firefighting module, developed under direction of MSFC's Technology Utilization Office, the *Marshall Star* reported. The manufacturer, Northern Research and Engineering Corp. of Cambridge, Mass., would deliver it to NASA representatives in Boston for transfer to the Coast Guard on completion of an acceptance test.

Since MSFC had developed technology for lightweight highly efficient pumps in rocket engines, the Coast Guard had requested help in designing a unit small enough to be lowered onto the deck of small craft but capable of pumping hundreds of gallons of water per min. The module was 4ft wide, 5ft high, and 6ft long, and weighed 2500 lb, including fuel for 3hr of operation, and all equipment stored internally. Two people could set it up rapidly without tools, and it could deliver full output flow within 10min.; a special feature was a pair of fiberglass water cannons, or monitors, weighing 40lb. The module could draw water from the sea through a lift up to 20ft long and pump at least 1000gal per min through each monitor.

Commercial applications included use on light trucks by local fire departments, on docks and ships for harbor fires, and for forest, offshore oil rig, and high-rise building fires, as well as an emergency booster pump for municipal water and for flood control and military operations. Aubrey Smith, head of TU activities at MSFC, said the firefighting module showed "how NASA-developed technology and expertise can be adapted for down-to-earth uses." (*Marshall Star*, Dec 6/78, 1)

• The *Marshall Star* reported delivery to Cape Canaveral of a light ion-mass spectrometer (LIMS) developed by MSFC scientists, for integration

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with other instruments on the USAF's SCATHA (satellite charging at high altitudes) scheduled for launch on a Delta Jan. 25, 1979. SCATHA instruments would collect data on electrically charged particles in the upper ionosphere and magnetosphere to help solve the problem of static-electricity buildup on satellite surfaces at geosynchronous altitude. The LIMS would measure density, temperature, and speed of low-energy ions from all directions, as sensors separated hydrogen, helium, and oxygen ions and recorded their speed and numbers. Martin Marietta Co., integration contractor, had delivered the instrument to MSFC 3wk previously, and MSFC personnel had installed flight sensors and completed final calibration before delivering it to the Air Force at the Cape. Designed for a nominal 1yr lifetime, SCATHA might return data for possibly 3yr or more. (*Marshall Star*, Dec 6/78, 2)

- ESA announced successful completion Dec. 5 of the fourth development test of the Ariane launcher's first-stage inflight configuration by the Société Européenne de Propulsion, Vernon, France. The 142.9sec test (a propulsion time corresponding to depletion of the N204 propellant) confirmed that the propulsion system would function for the nominal duration of the stage's flight, 142.5sec. Also tested was the silicon and phenolic-resin (SEPHEN 301) material to be used for Viking-engine nozzles, replacing other materials exhibiting inadequate resistance in previous tests.

The second test of the third-stage flight configuration, scheduled for Nov. 28 at Vernon, had been interrupted when failure of the cryogenic engine (H8) to ignite caused a small explosion that damaged the propulsion bay, but not the test stand. ESA was investigating the incident and its effect on the development timetable; it would issue a new timetable in early January 1979, with the target of an operational Ariane in 1981 unaffected. (ESA Release Dec 6/78)

December 7: ESA announced that its council had unanimously authorized Roy Gibson, director general, to sign an agreement with Canada on Canadian participation in ESA's basic activities. Canada would participate in meetings of ESA's delegate bodies, and would have two delegates on the Council who could vote on questions relating to activities covered by the agreement. Canada's financial contribution supporting its participation in general studies of future projects would be 1% of the net fixed common costs of ESA's general budget. The agreement, a step toward closer relations between Canada and ESA, confirmed the Canadian government's intention to expand collaboration in European space activities and to establish permanent institutional relations with ESA. Cooperation between Canada and ESA had begun in 1972, when ESA agreed to provide systems for Canada's experimental comsat CTS.

A March 1977 agreement defined the terms of cooperation in remote sensing. (ESA Release Dec 7/78)

December 8: NASA announced that 8 women volunteers aged 45 to 55 had emerged in November hale and hearty after nearly a month of tests at ARC's Human Research Center during which they were isolated from friends and family. Like 40 other men and women aged 25 to 55 who had volunteered for space program tests since 1973, the ARC group had participated in a study of the effects of weightlessness on the human body.

Researchers from ARC's biomedical research division were interested in the tolerances and responses of a body reentering earth's gravity after experiencing zero gravity in space. The long-term NASA experiment, the Bed Rest Program, would extend over the next 12mo with 2 more groups—8 men, then 8 women, all aged 55 to 65—undergoing the same tests. Prolonged horizontal bed rest (a physiological approximation on earth of zero-gravity) would cause bodily changes within 24 to 48hr and would maintain them throughout the program. Having approximated the effects of zero gravity, researchers could study human responses to the introduction of both normal and abnormal Shuttle-reentry gravity forces. Other tests in cooperation with Johnson Space Center had evaluated the protection offered by antigravity suits against reentry stresses.

Those volunteering for the program in response to newspaper advertisements had undergone a series of exacting physical and psychological tests. The 3-phase study began with the 8 subjects moving into the 12-bed ARC research facility. After a 9-day control period came 10da of total bed rest, followed by a 5-day recovery period. During the bed rest experiment, participants had to remain flat except to raise their heads slightly to eat. The subjects even showered in a horizontal position, being moved on a wheeled gurney to a specially designed shower. They had no visitors, but could have incoming and outgoing telephone calls. The routine did not deviate from three meals a day, lights off at 11pm, on at 7pm. At times the lower body underwent negative-pressure tests in a box. Researchers took daily blood samples and deep body temperatures. Electrocardiograms constantly recorded heart rates, and a "biobelt" around the waist constantly sent data to recorders. Before and during bed rest, the subjects took centrifuge rides designed to measure reflexes and coordination as the body made adjustments. The researchers tried to keep the subjects cheerful and to relieve natural boredom with books and games; each bed had stereo and color television. Medical attendants (doctors, nurses, and technicians) were on hand at all times. (NASA Release 78-185)

• NASA announced it would physically integrate all Space Shuttle/Spacelab experiments at Kennedy Space Center. Extensive analysis and cost studies had confirmed an earlier tentative decision to do the work at KSC rather than at centers managing the Spacelab mission. "Physical integration" consisted of installing experiments on Spacelab's racks and pallets. After Spacelab operations became routine in the mid-1980s, physical integration should require about 100 civil service and contractor man-yrs per yr at KSC. The analyses required to integrate experiments for each mission would continue at assigned Spacelab management centers. (NASA Release 78-186)

- MSFC announced it had awarded 28 contracts valued at $50 000 or more during October 1978. Organizations receiving contracts were United Technologies Corp.'s United Space Boosters, $250 888, modification of a facility for Shuttle assembly, checkout, launch operations, and refurbishment; McDonnell Douglas Co.'s Spacelab Integration Div., $2 400 540, engineering changes for Spacelab integration; Sperry Rand Corp., $335 329, increased funds for delivering Shuttle SRB multiplexer/demultiplexer; Garrett Corp., $469 143, engineering changes in design, development, manufacture, test, and delivery of solar heating and solar heating/cooling systems for operational testing; Martin Marietta Corp., $600 000, cost adjustments for designing structural attachments for large space structures; Univ. of Chicago, $3 460 230, addition of cosmic-ray investigation provisions to contract for Skylab 2 experiment; Univ. of Iowa, $2 125 198, ejectable plasma-diagnosis experiment for Spacelab 1 and similar experiment for Spacelab 2; Smithsonian Inst., $806 192, work on HEAO-B x-ray telescope; Bendix Corp., $1 000 000, changes to contract for Shuttle SRB electronics assembly and associated equipment; and Naval Research Laboratory, $1 275 300, increase in funds for solar-ultraviolet experiment on Spacelab. (MSFC Release 78-132)

- Representatives of LeRC, ARC, LaRC, other government agencies, and industry had met at Dryden Flight Research Center for what was probably the final symposium on NASA's YF-12 aircraft program begun in the late 1960s, the *Lewis News* reported. The airplanes would be mothballed by March 1979. DFRC's Dr. James Albers, symposium chairman, said the symposium was to "disseminate recent research findings and stimulate exchange of information among participants engaged in design or research related to high supersonic flight."

The YF-12 had given NASA an opportunity for research on sustained supersonic flight. Several NASA centers had investigated propulsion-system performance and the dynamics of mixed compression inlets; aeroelastic effects and thermal problems of high Mach number flight; and techniques of measuring aerodynamic data and operational parameters in extreme temperatures. Researchers had conducted a parallel series of laboratory experiments to augment the findings of the flight program.

The symposium ended with an industry-government panel on "Future Perspectives in Supersonic Flight." (*Lewis News*, Dec 8/78, 7)

- INTELSAT announced it would use both the Space Shuttle and ESA's Ariane launch vehicle to orbit later spacecraft in the Intelsat V series. INTELSAT's board of governors had ordered two Shuttle launches from NASA and one Ariane launch from ESA. Worth a minimum of $82 million, the orders would cover the orbiting of the 5th, 6th, and 7th satellites in the Intelsat V series during 1981-82. The Shuttle would give INTELSAT its first experience with reusable launch vehicles; Ariane would be INTELSAT's first use of a non-U.S. launch vehicle.

INTELSAT said its decision was difficult because neither vehicle had been proven in operation. The organizations had scheduled its earlier Intelsat V satellites, like the then-current Intelsat IV and IV-A satellites, for launch on NASA's Atlas Centaur. The agreement had provided for an Atlas Centaur backup for the series, should the first Shuttle not be available. (INTELSAT Release 78-34-I)

December 11: The National Air and Space Museum would commemorate the 75th anniversary of the Wright brothers' historic Kitty Hawk, N.C., flight with the opening of a new exhibit featuring the 1903 Wright Flyer, the *Washington Star* reported. The exhibit, including pages from the 1903 patent, photographs, and other memorabilia, would open three days before the actual anniversary of the Wright brothers' flight Dec. 17, 1903. The special Wright exhibit would be on display for a yr.

Paul Garber, first curator of the Smithsonian's old National Air Museum, wrote in his book commemorating the occasion: "I was not at Kill Devil Hill to see Orville Wright make that most epochal of all pioneer flights. I wish I had been. But six years later I saw him piloting the Wright military flyer at Fort Myer, Va., and 39 years after that, I had the honor of bringing the first Wright 'aeroplane' back home and installing it in the Smithsonian Institution's Arts and Industries building. (The plane had been in England.) I also helped obtain our third Wright airplane (the Vin Fiz) . . .

"One day an acquaintance visited the museum with Orville Wright; . . . and I had the pleasure of meeting the first man to make a powered, sustained, and controlled flight . . . Later, he assisted me in preparing an exhibit illustrating some of the accomplishments of his brother and himself. I saw him on many occasions, and as I recall those times I only wish that I had asked him more questions! Regrettably he died on Jan. 30, 1948 [Wilbur Wright had died in 1912 of typhoid fever.]" In an interview before the exhibition opened, Garber said, "I can look through the window of a modern jetliner and see the Wright aircraft flying along, changing the course of history." (*W Star*, Dec 11/78, DC-1)

• *Av Wk* reported the Federal Aviation Administration prediction of an increase in the general aviation fleet from 186 600 active civilian aircraft in 1978 to 310 800 in 1990. Preliminary data indicated that hrs flown in general aviation aircraft reached 38.6 million in FY78, up 5.2% from 36.7 million in FY77. The FAA also predicted that by 1990 general aviation aircraft would be flying 67.4 million hr, increasing 4.8% yearly to 74.6% over the 1978 total. The lower increase of annual hrs flown resulted from the current emphasis on conservation of resources, FAA said. Operating costs, expected to rise more rapidly than inflation, would affect private flying for pleasure. (*AvWk,* Dec 11/78, 70)

December 12: NASA announced it had signed a $77 million contract with General Electric Space Division to build Landsat-D, most advanced earth-resources-monitoring satellite system to date, scheduled for launch in 1981 to view the earth from more than 640km (400mi) altitude. In addition to a multispectral scanner (MSS) like that on the first three Landsats, Landsat-D would carry a thematic mapper (TM) with spatial resolution three times as detailed as that of MSS. The new sensor could distinguish area features as small as 0.2-acre instantaneous field-of-view (IFOV) compared to the 1.2-acre IFOV resolution of present systems. The cost included a $5 million fee with possible additional earnings up to $4.3 million, depending on system performance once the satellite was in orbit. The contract included a backup spacecraft, data management system, operations control center at GSFC, transportable ground station, and a Landsat assessment system to demonstrate advantages of the TM over the MSS.

Landsat data had served primarily for monitoring earth resources and managing food, fiber, and water resources; mineral and petroleum explorations; and landcover and land-use mapping. The U.S. Depts. of Agriculture, Commerce, Interior, and State, and a number of states and foreign governments would participate in the Landsat-D mission. (NASA Release 78-188).

• FBIS reported that Oleg Gazenko, director of the USSR's Manned Spaceflight Institute of Medico-Biological Problems, said in an interview that cosmonauts Vladimir Kovalenok and Alexander Ivanchenkov were physiologically "as healthy as they were before the [*Soyuz 29*] spaceflight" [see Nov. 2]. The record 140-day flight had caused some functional changes: . . . "the cosmonauts lost a part of the muscle mass, which they have now restored. They returned to earth with erythrocytes that were born in space. The average life span of erythocytes is 120 days, and they are fully renewed during this period."

Gazenko said that the cosmic erythrocytes tended to be smaller, though they fully retained the main function of carrying oxygen to the tissues. "As time passes, the erythrocytes that were born in weightlessness will perish. But what will those that will replace them be like? Identical to those that were born before the space flight? Apparently yes, because our organism is a wonderful instrument of self-regulation; it excellently arranges all the processes taking place in it in such a way that they would meet the demands made by those conditions in which man is staying."

Gazenko had directed research that substantiated the possibility of manned spaceflight, and had received the 1978 USSR state prize for studies of ways to counteract unfavorable effects of weightlessness on the human organism, making lengthy manned spaceflights possible. (FBIS, Tass in English, Dec 12/78)

December 13: MSFC reported that LaRC scientists were using the Pioneer Venus mission for an atmospheric-drag experiment to measure for the first time the orbital decay of a spacecraft in orbit around another planet. Orbital decay would result from atmospheric friction as the low point of *Pioneer Venus I*'s orbit came within 150km (93mi) of Venus's surface. From atmospheric drag, scientists could determine variations in the density of Venus's upper atmosphere and deduce composition and temperature. Changes in the frequencies of the spacecraft's radio signals has determined orbital decay with an accuracy of better than one part in a million. (*Marshall Star*, Dec 13/78, 2)

December 14: The Intl. Council of Scientific Unions and the World Meteorological Organization (WMO) announced that more than 140 nations would participate in the largest international scientific experiment ever held, beginning in January 1979. The Global Weather Experiment (GWE) would establish the practical limits of weather forecasting and design a global observation system to achieve them. During the 12mo experiment, a massive array of scientific personnel and observing equipment would monitor earth's oceans and atmosphere to compile the most complete record of global weather data ever assembled. The experiment, part of the Global Atmospheric Research Program (GARP), would be a joint effort of the 2 organizations and all 147 member nations of WMO; 5 other international organizations were also contributing. U.S. participants would include the Depts. of Commerce, Defense, Energy, Interior, Transportation, and State; NASA; the Natl. Center for Atmospheric Research; the Natl. Science Foundation; the Defense Nuclear Agency; the Air Force, Army, Navy, and Coast Guard; and many academic institutions. NOAA would coordinate U.S. participation.

The experiment would supplement the existing World Weather Watch (now generating more than 40 000 observations daily) with 10 satellites, about 50 research vessels, 110 aircraft (including 10 research planes), 300 high-altitude constant-level balloons, and 300 instrumented drifting buoys. One focus of attention would be the broad belt around the equator, an enormous heat sink absorbing much of the sun's energy and generating much of the world's weather, but so far comparatively unobserved. To obtain more data on this crucial region, GWE would operate observing systems during two special periods (Jan. 5 to March 5, and May 1 to June 30) to gather vital tropical-wind information. The combined systems would generate weather data for 85% of the earth's area not covered by the World Weather Watch.

At the end of the Global Weather Experiment Nov. 30, 1979, centers in a number of nations would process the data and forward the results to World Data Centers in Moscow and Washington, D.C., and to meteorological research laboratories in Bracknell, England, and Princeton, N.J. Scientists would use computers to refine the data and construct for the first time a complete 12-mo world-weather history. They would run computer experiments using this unique record to test their results, and to determine not only the practical limits of weather prediction but also the data needed to reach these limits and the kind of system needed to gather the data. The socioeconomic impact of improved weather forecasts could be dramatic; industries, for example, could benefit from knowing what the weather would be as far as 8 to 10 (or even 14) days in advance. (GWE Release 78-1)

December 15: DFRC and the Jet Propulsion Laboratory had joined in a study of the "Mars airplane" (a derivative of the Mini-Sniffer), the DFRC *X-Press* reported. The idea of a Mars airplane resulted from a January 1977 meeting between David Scott, former director of DFRC, and JPL director Dr. Bruce Murray, who had offered JPL's assistance in perfecting the hydrazine engine of the Mini-Sniffer remotely-piloted vehicle (RPV) designed to fly at 70 000 to 100 000ft. The plane was originally a low-cost alternative to the U-2 for atmospheric research; DFRC's Dale Reed and JPL personnel had recognized the possibility that the Mini-Sniffer could cruise halfway around Mars in the planet's low gravity and thin atmosphere, using its unique nonairbreathing hydrazine engine.

Developmental Sciences, Inc. had received a $60 000 contract for designs to send four Mars airplanes folded into capsules to conduct low-altitude surveillance flights down Martian canyons and volcanoes and over icecaps. The researchers believed technology was advancing so quickly in lightweight solar cells, beamed-microwave energy, lightweight electric motors and batteries, and lightweight radioisotope electric generators, that it would soon produce a generation of high-flying long-endurance long-range aircraft, the paper noted. (DFRC *X-Press,* Dec 15/78, 3)

• A jack-in-the-box parachute had proved to be an effective spin-recovery device, DFRC *X-Press* reported. Known as jack-in-a-box because of its deployment mechanism, the parachute had been installed in the nose of a spin-research vehicle, a 23-ft model of a modern fighter air-launched from a B-52 at 50 000ft and flown into a spin at 25 000ft. On command from a pilot on the ground, the nose parachute had deployed and recovered the vehicle from the spin. After parachute jettison, the SRV ground operator flew the SRV to a near-perfect landing on the Rogers dry lakebed. Results indicated that maintenance of a relatively clean airflow around the nose of the aircraft would permit use of a significantly smaller parachute, simplifying its installation. (DFRC *X-Press,* Dec 15/78, 3)

- INTELSAT announced reduced charges for many of its satellite services for the ninth consecutive yr. Meeting in Washington, D.C., INTELSAT's board of governors had reduced the monthly charge for full-time two-way telephone circuits on an INTELSAT satellite (about 80% of the INTELSAT system) from $1140 to $960 beginning in Jan. 1979. Charges for on-demand telephone circuits (known as SPADE circuits) would drop from 16 to 14 cents/min. Original rate for satellite telephone circuits established by INTELSAT in 1965 was $5334/mo; since then, advancing technology had increased demand and improved efficiency so that INTELSAT could progressively reduce its rates. Marcel Perras of Canada, chairman of the board of governors, said INTELSAT was considering a 5-yr plan to lower the rate for satellite telephone circuits to less than $700/mo by 1983. (INTELSAT 78-35-1)

December 18: JSC announced that one of the world's most unusual freight airplanes, the Super Guppy, would deliver a high-fidelity mockup of the Space Shuttle orbiter crew compartment from the contractor in Calif. to neighboring Ellington AFB in Tex. for transfer to NASA, marking first use of the Super Guppy for delivering Space Shuttle equipment. NASA would install the mockup (a detailed model of the cockpit and living quarters on the Space Shuttle orbiter) in a JSC training area for use in crew familiarization. The nonworking mockup was built by Rockwell Intl., prime contractor for the orbiter.

The Super Guppy took aboard the mockup at Los Alamitos Naval Air Station near Los Angeles and flew it to Ellington, refueling at Davis-Monthan AFB, Tuscon, and Dyess AFB, Abilene. A modified Boeing YC-97J, the Super Guppy had the world's largest internal dimensions in an aircraft; it could accommodate the fuselage of a 747, if sectioned. Its present configuration, test-flown by late NASA pilot Joe Walker in late 1965, was first used by NASA early in 1966. The Super Guppy, equipped with 4 Pratt & Whitney T34 turboprops, had flown more than 2 million mi carrying NASA cargo and had seen extensive use in the Apollo and Skylab missions. It had last landed at Ellington AFB in June 1976. (JSC Release 78-58)

• LaRC announced selection of Telos Computing, Inc., Santa Monica, Calif., for negotiations leading to award of a contract to develop software for the Natl. Transonic Facility (NTF) wind tunnel at LaRC that would allow networking of four medium-sized computers to be the nucleus of NTF's instrumentation complex. The contract would cover collection and display of all research measurements, as well as automatic control of many wind-tunnel test parameters. Telos estimated the value of the cost-plus-fixed-fee contract at $1.2 million. Work would be performed at LaRC over a 3-yr period. (LaRC Release 78-86)

• Engineers from Rocketdyne and NASA were trying to determine why a liquid-oxygen heat exchanger on a Space Shuttle main engine had failed during a test at the Natl. Space Technology Laboratories, Bay St. Louis, Miss., *Av Wk* reported. This was the first failure of a heat exchanger (an engine component converting liquid oxygen to gaseous oxygen to pressurize the Space Shuttle's external propellant tank). Earlier in 1978 the Natl. Research Council's Assembly of Engineering had noted that, although the exchanger had not encountered any difficulties, the system "poses a potential threat to the total shuttle system" from a single-point-failure standpoint. The committee said that, whereas redesign to add systems redundancy was impractical at that point, the system warranted continued examination for potential design improvements. NASA agreed with that assessment.

Inflight heat-exchanger failure might start a serious fire or explosion that could result in loss of the spacecraft. Failure during the test had resulted in some engine damage, but none to the test-stand. Testing with different engines was continuing. (*AvWk,* Dec 18/78, 8)

December 19: NASA announced it had decided not to reboost or deorbit the Skylab space station in orbit around the earth because success was unlikely. Uncertainties that had developed in Skylab systems, Skylab lifetime, Space Shuttle schedule, and teleoperator-retrieval system (TRS) delivery had made further planning for a rescue mission impractical. Factors leading to the decision included deterioration of systems aboard Skylab (recurring control-moment gyro anomalies, marginal power conditions, and minimal attitude-control impulse gas); high sunspot activity that was accelerating decay of Skylab's orbit; and reviews showing that a Skylab-rescue mission would be difficult to arrange before April 1980.

Skylab, currently orbiting at about 426km (265mi) altitude, was being maintained in a low-drag attitude and would be continually monitored while NASA assessed the possibilities of damage on reentry, now predicted to occur between mid-1979 and mid-1980. Most of the vehicle would burn up during reentry, but some fragments probably would reach earth's surface. Skylab's flight path was 75% over the ocean; the probability of injury or damage from it was less than that from meteorites, according to estimates. (NASA Release 78-191)

At a press conference following the announcement, Bill Haines of the *Chicago Sun Times* asked: "Way back in the olden days I remember that there was a lot of talk about space rescue, and one of the philosophies seemed to be that if we got into trouble or the Russians got into trouble, the other side would come to the rescue. Have you made any approaches at all to the Russians to see if they could do anything about this? If not, why not? And do you intend to?"

John Yardley, associate administrator for Space Transportation Systems, answered: "This is a little different from the space rescues that we had talked about. As you know, part of the ASTP program was to design docking equipment that could be prototypes of that. And we still have a long-range plan with the Russians, albeit rather fuzzy, to some day have this capability.

"With respect to Skylab: After our ASTP, working with the Russians, of course, we had a fairly good working knowledge of the capabilities, at least that we knew of that were done in that program. And at least a year ago we got our own heads together and talked about whether or not they could do anything that we couldn't do. We concluded that there are many problems that we won't go into that it probably is not feasible, so we did not ask them. However, they are being informed of what we are doing here and if they make any proposals that we haven't thought of that could be useful, we will certainly entertain them." (NASA press conf Dec 19/78)

December 20: NASA announced it had selected Global Associates, Oakland, Calif., to provide operating services at the Michoud Assembly Facility, New Orleans, La. Services provided under the contract would support NASA program activity and missions of the Depts. of Agriculture, Defense, and Commerce tenanted at the Michoud facility, as well as refuse collection and telecommunications services at Slidell Computer Complex, Slidell, La. MSFC managed both facilities.

Under the 1-yr cost-plus-award-fee contract, with four 1-yr options for extension, Global Associates would provide management, personnel, and materials for plant engineering, maintenance, telecommunications, and property and supply, as well as mail, transportation, medical, and food services. Proposed cost over the 5-yr period was approximately $26.5 million. NASA's primary program at Michoud was manufacture and assembly of external tanks for the Space Shuttle, including those for service as test articles, on test flights, and on operational missions. (NASA Release 78-192)

- Boeing had awarded a $2 million contract to United Technologies'

Chemical Systems Division to build seven servoactuator systems (and two actuators for preflight testing) that would raise the inertial upper stage (IUS) to deployment position in the Space Shuttle payload bay, *Defense/Space Business Daily* reported. Each system would consist of two servoactuators (one for backup), composed of an actuator and electronic controller positioned on either side of a tilt table in the payload bay to which the IUS would be secured. On command, the system would physically tip the tilt table to a predetermined position (e.g., 58°) for IUS deployment. The actuator motor would drive an extendable shaft 41 to 57in long to rotate the tilt table. Pyrotechnic devices on the tilt table would release the IUS, and springs would launch it into space. First flight of the IUS on board the Space Shuttle was scheduled for 1980. (*D/SBD,* Dec 20/78, 239)

- ESA reported on the mechanical-qualification tests of the CAT/Apple/Meteosat-2 composite (a payload scheduled under the APEX program for the third test flight of Ariane in May 1980) taking place Dec. 12–22 in the CNES facilities at Toulouse. The tests were to check behavior of the payload structure and the subsystems under conditions arising during launch; results would be compared with mathematical models. Undergoing tests would be a dynamic mockup subjected by means of an electroacoustic exciter to longitudinal and transverse vibrations like those occurring in flight.

The payload being tested had three satellites mounted one above the other: the Ariane technological capsule (CAT), carried on all Ariane test flights; Apple, a technological satellite of the Indian Space Research Organization, which would carry a communications experiment; and ESA's meteorological satellite Meteosat-2 which would continue the Meteosat mission into 1980. Apple and Meteosat-2 would be the first satellites placed in geostationary orbit by a European launcher. These tests were the first conducted in Europe on such a heavy payload, 6.5m high and weighing 1574kg. (ESA Release Dec 20/78)

- FBIS reported the USSR had launched a communications satellite, *Horizont,* Dec. 19 under a program "for further improvement and development of communications systems and television transmissions." Satellite apogee was 48 365km; perigee, 2581km; period, 23hr 40min; inclination, 11.3°. *Horizont* carried improved multiplex-relay apparatus for transmitting telephone and telegraphic radio communications and TV programs, including those from the 22nd summer Olympic games in Moscow. It had a three-axis system for precision orientation, a power-supply system with independent guidance and alignment of the solar batteries with the sun, a thermo-regulation system, a telemetry system for transmitting data on onboard systems, a radio system for precision measurement of the orbit's parameters and control of the satellite, and an orbit-correcting system. All satellite systems were functioning normally. (FBIS, Tass in English, Dec 20/78)

December 21: NASA announced it had awarded Lockheed-California Co., Burbank, Calif., a contract to develop and evaluate in flight an augmented-stability active-control concept that would use a smaller horizontal tail on transport planes. Lockheed had estimated the total value of the cost-sharing contract, monitored by LaRC, to be $17.6 million; the government would pay approximately $15.8 million, Lockheed $1.7 million. Work would be performed over 44mo at Lockheed's Burbank facility.

An earlier NASA contract with Lockheed (Phase I of the energy-efficient transport program) was for conceiving aerodynamic and active controls that could increase energy efficiency of new and derivative civil-transport aircraft early in the 1980s. Results from that phase and from independently funded activities indicated that Lockheed was ready for flight demonstration of active controls to augment stability of a commercial air transport with a reduced horizontal-tail size. (NASA Release 78-193)

- *JPL Universe* reported NASA Administrator Robert Frosch had characterized the Pioneer Venus mission as "a superb success" in a message congratulating personnel at NASA centers and in the industrial and scientific communities. Frosch had added: "The precise execution of the multiprobe encounters December 9 and the continuing excellent performance of the orbiter could have resulted only from a well planned and competently executed program . . ."

The orbiter would continue its scientific measurements for 243da after Venus encounter; however, three small probes and a larger sounder had plunged into the Venusian atmosphere with destruction expected immediately upon impact. To the surprise of Pioneer Venus scientists, one probe had survived for 67min after impact, sending back information that would help confirm probe findings (particularly a wind experiment) before the 900° Venus temperatures silenced it. (*JPL Universe,* Dec 21/78, 1)

- INTELSAT announced it had awarded a $101 539 contract to General Electric Co., Valley Forge, Pa., for a reconfigurable-beam satellite communications antenna. Under the 15-mo contract GE would develop an antenna capable of beaming dual-polarized transmissions that could be reshaped on command while the satellite was in orbit; GE would also fabricate portions of such an antenna for demonstration. Reconfigurable-antenna developments might be incorporated into INTELSAT satellites launched during the 1980s. (INTELSAT Release 78-36-M)

- FBIS reported the USSR interplanetary spacecraft *Venera 12* had reached Venus Dec. 21 after a 98-day flight covering over 240 million km. The descent module had entered Venus's atmosphere at 11.2 km/sec and soft-landed, transmitting scientific information from the planet's surface for 110min. During descent, the module made precise chemical analyses of the composition of the atmosphere and clouds, a spectral analysis of solar radiation scattered in the atmosphere, and a study of electric charges in the atmosphere from 62m above the planet's surface. Scientific measurements continued after the module landed. The *Venera 12* station was continuing its flight in space, carrying a Soviet-French experiment for studying solar and galactic gamma flares.

Venera 11, launched 5da before *Venera 12*, would reach Venus Dec. 25. (FBIS, Moscow Dom Svc in Russian, Dec 21/78)

December 22: NASA reported *Voyager 1* was 598 975 000km (372 186 000mi) from earth; *Voyager 2*, 544 445 000km (338 303 000mi). One-way communication time for *Voyager 1* was 33.3min, for *Voyager 2* 30.2min. Spacecraft distance traveled since launch was 931 872 000km (579 038 000mi) for *Voyager 1*, 936 428 000km (581 869 000mi) for *Voyager 2*. *Voyager 1*'s velocity relative to earth was 70 830km/hr (44 013mi/hr), *Voyager 2*'s 68 537km/hr (42 586mi/hr). *Voyager 1*'s velocity relative to the sun was 49 262km/hr (30 609mi/hr); *Voyager 2*'s 44 334km/hr (27 548mi/hr). (NASA Release 78-194)

December 25: FBIS reported the Soviet Union's *Venera 11* had reached Venus Dec. 25, and its descent module had made a soft landing some 800km from where *Venera 12*'s descent module had landed. Main task of *Venera 11* and *12* was to examine the characteristics of various areas of Venus. After the descent module separated from *Venera 11* Dec. 23, the spacecraft had proceeded on a flyby trajectory some 35 000km from the planet's surface. The *Venera 11* module, during descent and while on the planet surface, had performed research similar to that done by the *Venera 12* module (scientific and technical experiments and exploration of Venus's surface at 446°C and pressure of 88 atmospheres) for 95min. Descent-module data received by *Venera 11* were relayed to earth. After leaving the zone of radio visibility and completing receipt of data, *Venera 11* would continue in a heliocentric orbit. Scientific measurement and research begun on the earth-Venus interplanetary route would continue during the flight of *Venera 11* and *12*. Data obtained from the two spacecraft would be processed and studied in the institutes of the USSR Academy of Sciences. (FBIS, Tass Intl Svc in Russian, Dec. 25/78)

December 26: NASA announced the five *Pioneer Venus* atmospheric-entry craft reaching Venus and the companion craft in orbit around

Venus were the highlights of its space-exploration activities in 1978, the agency's 20th anniversary yr. NASA had conducted 20 launches in 1978, mainly for other organizations and agencies; it was the third yr in NASA history with a 100% launch-success record. It had also seen completion of major milestones in preparing for crew-carrying Space Shuttle missions scheduled to begin late in 1979. (NASA Release 78-190)

December 27: NASA reported a delegation from the People's Republic of China had been discussing with U.S. officials since Nov. 28 the possibility of U.S.-PRC cooperation in peaceful uses of space technology. The delegation also had visited several NASA centers and U.S. aerospace industrial establishments. NASA Administrator Dr. Robert Frosch headed the U.S. delegation; Dr. Jen Hsin-min, director of the PRC Academy of Space Technology, the Chinese delegation.

Following up a visit to PRC in July by presidential science adviser Dr. Frank Press, the discussions had produced an informal agreement on developing a civilian communications system for PRC. China would purchase a U.S. satellite communications system, including ground receiving and distribution equipment; the U.S. would put the space portion of the system into geostationary orbit, and China would take over its operation. A similar informal agreement covered PRC purchase of a ground station capable of receiving earth-resources information from U.S. Landsat remote-sensing satellites including the Landsat D currently under development.

The PRC delegation would remain in the U.S. until mid-Jan. for further technical discussions. Both sides expressed satisfaction with the discussions, and agreed on further talks to work out details of the informal agreements and to consider other forms of civilian space cooperation. (NASA Release 78-197)

- NASA announced appointment of Robert Aller as director of tracking and data relay satellite system (TDRSS) program office at the NASA Hq Office of Space Tracking and Data Systems. Effective Jan. 2, 1979, Aller would be responsible for planning, direction, and evaluation of the TDRSS program. Working with NASA program and project managers, he would determine requirements and develop and implement plans for TDRSS support of NASA earth-orbital spaceflight missions. Western Union Space Communications, Inc., would provide NASA with TDRSS tracking, command, and data-relay services under a 10yr telecommunications agreement. Aller had been deputy director of the expendable launch vehicles program in the NASA Office of Space Transportation Systems, and had served in the Apollo-Soyuz Test Project and the Skylab, Apollo, and Gemini programs. He had received the NASA medal for outstanding leadership and two NASA exceptional service medals. (NASA Release 78-195)

December 28: NASA announced that 11 of its 16 launches scheduled for 1979 would be reimbursables (launched by NASA for other agencies or corporations). Paying customers included DOD, NOAA, the United Kingdom, Western Union Corp., ComSatCorp, and RCA. As in 1978, most of the 1979 launches would emphasize use of space for the direct benefit of people: communications, environmental, and meteorological information.

Activities in 1979 would include the first launch and orbital flight of the Space Shuttle; Jupiter and Saturn encounters by two Voyager spacecraft; and the *Pioneer 11* flyby of the rings of Saturn. NASA would launch the Space Shuttle from KSC into its first orbital flight Sept. 28 with astronauts John Young and Robert Crippen as crew. They would land 53hr later at DFRC.

The 1979 schedule would begin with two launches Jan. 25: DOD's spacecraft charging at high altitudes (SCATHA) from Cape Canaveral, and a stratospheric aerosol and gas experiment (SAGE-A) from Wallops Flight Center. In April NASA would launch NOAA-A for NOAA and Navy-20 for DOD from Vandenberg AFB. It would launch in May FltSatCom-B from Cape Canaveral, and UK-6 for the United Kingdom from WFC; Westar-C in July and Intelsat V-A in Aug., both from Cape Canaveral for ComSatCorp; in Sept., its third high-energy astronomy observatory HEAO-C from Cape Canaveral, and its Magsat-A from Vandenberg; in Oct., the solar maximum mission (SMM-A) from Vandenberg. NASA would launch Intelsat V-B from Cape Canaveral for ComSatCorp in Nov.; in Dec., NOAA-B for NOAA from Vandenberg, and RCA-C for RCA from Cape Canaveral. (NASA Release 78-196)

December 29: Five European and U.S. scientists named in July as experimenters on NASA/ESA's first Spacelab mission would begin training in the U.S. in Jan. 1979, NASA announced. The training tour, taking them to seven U.S. and two Canadian cities, would prepare them to operate equipment for scientific investigations that would fly aboard the Space Shuttle in 1981. Selection and training of these scientists to fly in space had been a departure from earlier NASA practice, as they were not career astronauts and had been chosen for the mission by the scientists who devised the experiments. This was also the first time that Western Europeans would fly in space, and the first time that NASA would orbit people who were not U.S. nationals. Of the five persons training for the mission, two—a European and an American—would actually fly on Spacelab 1; the others would operate ground-based experiment equipment and support the two in orbit.

The chosen five had just returned from Europe where they had been since Oct. learning to operate the experiments chosen for Spacelab by European scientists. The science payload was about equally divided between NASA and ESA experiments in terms of weight, power, and volume requirements. Areas of investigation would include stratosphere and upper-atmosphere physics, materials processing, space-plasma physics, biology, medicine, astronomy, solar physics, earth observations, and technology areas such as thermodynamics and lubrications. MSFC would manage training in the U.S. as part of its overall responsibility for the first three Spacelab missions; ESA had managed the training in Europe. (NASA Release 78-198)

During December: NASA announced it had silenced the scientific instruments aboard the orbiting solar observatory *Oso 8* by radio command sent from Goddard Space Flight Center to NASA's tracking station in Orroral, Australia, on the satellite's orbit no. 18 072. A few moments later the Australia station confirmed that the satellite's radio transmission had stopped. Last of the "sunshine" satellites that had begun investigating the sun with the launch of *Oso 1* in 1962, *Oso 8* (launched from Cape Canaveral June 21, 1975) had surpassed its 1-yr design lifetime by 2yr. It had far exceeded all prelaunch mission objectives, and had obtained the most accurate observations yet of the solar chromosphere and transition regions, giving scientists a better understanding of these.

Dr. Roger Thomas, *Oso 8* project scientist at GSFC, said that the lessons learned from 16yr of OSO satellites had been instrumental in developing new experiments for future studies of the sun such as next yr's solar maximum mission. Four of the eight experiments aboard the 1064kg *Oso 8* had been designed to measure the sun during the quiet (solar minimum) period. Solar activity had increased substantially, and the solar-science community was preparing to study a period of maximum solar activity, in part through launch of the solar maximum mission in Oct. 1979. The nonsolar high-energy astrophysics experiments on *Oso 8* also had made significant observations of the celestial sphere. These experiments had been superseded by *Sas 3*, *Heao 1*, and *Heao 2*. The *Oso 8* control center at GSFC would be reconfigured to support the SMM mission. (*NASA Actv*, Dec 78, 12)

- NASA reported procurements during FY78 totalled $3660 million, 3.6% more than during FY77. Approximately 81% of the net dollar value was placed directly with business firms, 5% with educational and other nonprofit institutions or organizations, 8% with the Calif. Inst. of Technology (for operations conducted by or through JPL), and 5% with or through other government agencies; 90% of the dollar value of the latter resulted in contracts with industry. About 53% of funds placed by NASA under JPL contracts resulted in subcontracts or purchases with business firms. In short, about 90% of NASA procurement was contracted to private industry. Of total direct awards to business firms, 72% were competitive procurements (either through formal advertising or negotiation) and 28% were noncompetitive.

Small business firms had received $282 million (10%) of NASA's direct awards, indicating that most agency awards to business firms were large continuing R&D contracts for major systems or items of hardware generally beyond the capability of small business firms on a prime-contract basis. However, of the $633 million in new contracts worth $10 000 or more awarded to business firms during 1978, small business received $137 million (22%); in addition to direct awards, small business received substantial subcontract awards from 75 of the NASA prime contractors participating in its small business subcontracting program. Total direct awards plus known subcontract awards to small business aggregated $513 million, 17% of NASA's total (direct plus indirect) awards to business firms. Included in awards to small business firms were $75.852 million awarded to minority business enterprises: $14.064 million in direct awards, $32.151 million under Section 8(a) of the Small Business Act, and known subcontract awards of $29.637 million.

In 1978, 49 states and Washington, D.C., participated in NASA prime-contract awards of $10 000 and over. These larger awards went to 2068 business firms in 46 states and D.C., and to 341 universities and nonprofit organizations in 47 states and D.C. Labor-surplus areas in 40 states had received 53% of the awards. (NASA ann proc rpt FY78)

- NASA announced the inception of Orbit 81, an RCA educational program to involve inner-city high school students in designing and developing a scientific experiment for launch on the Space Shuttle in 1981. The program had resulted from discussions among representatives of the Camden, N.J., public school system, NASA, and RCA. Other high schools were conducting similar programs, but NASA officials called the Camden project unique because it was the only "total involvement program covering all the disciplines, arts, and skills" taught in the curriculum. Students taking courses other than science and mathematics could be active participants in the project. Selection of an Orbit 81 experiment would take place when students had gained enough scientific insight to participate in the decision. The program would include enrichment courses in space science, summer sessions, and tours of NASA and RCA facilities. RCA had donated surplus laboratory equipment to the schools; NASA would provide literature, special programs, lectures, and demonstrations. Students of Camden and Woodrow Wilson High Schools had attended a space colloquium presented by NASA and RCA.

RCA had made an initial payment to NASA as part of the $10 000 reservation fee to ensure that the Orbit 81 payload, which could weigh up to 90kg and occupy no more than 0.14m³, would have a place aboard the Space Shuttle when launch time arrived. (*NASA Actv*, Dec 78, 11)

• NASA announced that its administrator, Dr. Robert Frosch, had accepted for NASA a document commemorating the anniversary of Charles A. Lindbergh's solo trans-Atlantic flight from New York to Paris in the "Spirit of St. Louis" on May 20, 1927. Copies of the framed Flight Philatelic Document, containing a series of American and French Lindbergh stamps and cancellations tracing the history of the aviator's achievement, had been presented to 25 persons and organizations in the U.S. and France. Friends of the Nassau County Museum, Long Island, N.Y., had produced the tribute and selected the recipients, including President Jimmy Carter, French President Valery Giscard d'Estaing, Anne Morrow Lindbergh, and museums and agencies linked to aviation. Each of the documents bore seven American and French Lindbergh stamps with key cancellations, and each document was autographed by President Carter, President d'Estaing, Paris Mayor Jacques Chirac, U.S. Postmaster General Benjamin Bailer, French Postal Secretary Norbert Segard, and Mrs. Lindbergh. (*NASA Actv*, Dec 78, 12)

• DOT's *National Transportation Report* noted that the department had been using administrative action to improve transportation. For example, while working for the Aviation Regulatory Reform Act, the department had led a federal interagency task force to develop guidelines for U.S. negotiators in reaching air service agreements with other countries. This had resulted in bilateral air service agreements with 13 nations that would increase competitive opportunities for airlines and lower passenger fares. Another major DOT aviation action was Secretary Brock Adams's decision to allow existing Concorde supersonic aircraft to fly over U.S. territory, at the same time requiring future SSTs to meet the same noise standards as subsonic aircraft. (*Natl Transp Rept* Jan 77-Dec 78, 3)

• The AFSC *Newsreview* reported that the USAF's Geophysics Laboratory (AFGL) had successfully completed a rocket test flight of equipment to cope with lightning-like discharges that could affect earth-orbiting satellites. These high-voltage discharges could interrupt transmissions of information to earth stations from geosynchronous satellites. A sudden rush of electrical current could confuse control circuits, causing a satellite to behave erratically or fail to function. Scientists were still analyzing information from the 160mi-high rocket flight, but preliminary results showed that the electrical buildup—which could reach thousands of volts—could be controlled by emitting negative or positive charges from the spacecraft.

An Astrobee F sounding rocket carried equipment that released either negative charges (electrons) or positive charges (ions) as the electrical charge built up on the rocket body. This either kept the charging to a low voltage or provided an electrically conductive path around the rocket body so the charge could leak off slowly. The rocket payload contained instruments nearly identical to those scheduled for orbit in Jan. on a SCATHA (spacecraft charging at high altitudes) satellite as part of a test program managed by SAMSO, Los Angeles. (AFSC *Newsreview*, Dec 78, 9)

- The USAF's Aeronautical Systems Division (ASD) had awarded Hughes Aircraft Co., Canoga Park, Calif., a $90.25 million contract for engineering development and test of the AGM-65D imaging infrared (IIR) Maverick missile, the AFSC *Newsreview* reported. A 35-mo engineering-development program designed to fine-tune the IIR version of Maverick would ensure that the weapon incorporated the state-of-the-art and was producible, maintainable, and reliable. ASD officials said testing, a key element in advanced development, would be equally crucial as the IIR program moved into the engineering development phase. The 16-mo test series would begin with ground-based studies and captive flight tests using helicopers and fixed-wing aircraft. Live firings of both telemetry- and warhead-equipped missiles from A-10, A7D, and F-4D and -E aircraft would complete the rigorous flight-test schedule.

The IIR guidance system (fourth and most sophisticated mate to the already-proven Maverick) would also be used with two guided bombs, the Air Force's GBU-15 and the Navy's Walleye. The IIR Maverick's digital-centroid tracker could pick up heat images generated by a target, calculate its approximate center, and guide the missile to target impact. USAF plans called for procurement of more than 31 000 IIR Maverick missiles; production would begin in mid-1981. (AFSC *Newsreview*, Dec 78, 7)

- The AFSC *Newsreview* reported that F-15 fighter pilots had come closer to better anti-G (gravity forces) protection, with airworthiness certification of a high-flow ready-pressure anti-G valve developed by the USAF School of Aerospace Medicine. Tests of the valves installed in two F-15s at Edwards AFB, Calif., had checked their reliability under flight conditions. Alar Products, Inc., Macedonia, O., was manufacturing 15 of the high-flow anti-G valves, and the ready-pressure attachment would be manufactured and added to the valves at USAFSAM. The valves would be installed in F-15s at Holloman AFB, N.M., and tested for 2 to 3mo. If test results were favorable, the valve would be further developed by the Aerospace Medical Division's life support system program office at Wright-Patterson AFB. (AFSC *Newsreview*, Dec 78, 12)

- The AFSC *Newsreview* reported that, pending arrival of the age of the

Space Shuttle, the USAF Space and Missile Systems Organization (SAMSO) was modifying a Titan III 34D booster to ensure prime and backup launch capabilities during Space Shuttle transition. The 34D was a modified Titan IIID that the USAF had put into operation in 1971; SAMSO had recommended it in 1975 to the Defense Science Board studying how DOD could manage an orderly transition from expendable to reusable launch vehicles. Instead of a variety of boosters, the 34D would use a common Titan III core for east- and west-coast launches, with the option of dedicating a 34D launch vehicle to either coast as late as 6mo before launch.

The 34D also was compatible with the new inertial upper-stage (IUS) vehicle, another SAMSO project in full-scale development by Boeing Aerospace Co. During the Space Shuttle backup era beginning in 1980, the 34D/IUS combination would be contingency booster for top-priority defense payloads. Plans called for development of seven 34D boosters to be used first for launching two defense satellite communications system (DSCS) spacecraft in July 1980 from Cape Canaveral. Four of the seven vehicles would serve east coast launches using the IUS, and three would serve polar launches from Vandenberg AFB.

Differences between the 34D and Titan IIID included solid-fuel rocket motors lengthened 5ft each to align with new common-core attach points and payload fairing modified to extend from 40 to 55ft. The new fairing would make the 34D payload environment nearly identical to that of the Shuttle orbiter cargo bay, a step toward upper-stage commonality. The 34D program was in final design stage under contracts with Martin Marietta Aerospace, McDonnell Douglas Corp., and United Technologies Corp. (AFSC *Newsreview*, Dec 78, 9)

• The Natl. Science Foundation reported that the 1979 federal budget presented in Jan. 1978 reflected greater austerity in R&D programs than during the previous 3yr, in which rate of R&D growth had exceeded the rate of inflation. R&D programs funded were those that met direct federal needs, general social and economic needs, or the need to accelerate private R&D efforts because of overriding national interest. The FY79 budget contained a rise for defense and space R&D programs of about 8% each, with only a 3% rise for all other R&D. This would reverse a 13-yr trend in which federal R&D support had shifted steadily toward civilian programs. The 1979 change had resulted not only from increases in defense/space support at rates at least equal to anticipated inflation, but also from expected real-dollar declines in support of civilian R&D areas of health, energy, and environment.

Federal R&D obligations rose 6% to an estimated $28.0 billion in the FY79 budget, an all-time high in current dollars, but inflation would mean a drop from the 1978 total figure in constant dollars. Later congressional actions had raised the level approximately 9% above that of

1978, and action on supplemental requests might add another 2 or 3 percentage points. Defense and space programs had accounted for more than 80% of the current dollar rise in R&D support in 1979. Funding for each of these was expected to increase by about 8% in 1979, whereas all civilian functions taken together would increase by only 3%. The defense/space share of the federal total in 1979 would be an estimated 62%, more than the 1978 share but still considerably lower than the 77% share in 1969. (*Analysis of Fed R&D Funding by Function,* Dec 78, vii)

- ComSatCorp announced it had derived 57% of its 1978 operating revenues from services provided through Intelsat satellites; 37% from maritime and U.S. domestic services provided by Comsat General through the Marisat and Comstar satellite systems; and 6% from its investment share in INTELSAT and operational and technical services.

ComSatCorp had been considering expansion into the growing environmental information services field in which satellite technology could play a significant, possibly essential, role. Comsat General, in cooperation with the U.S. Geological Survey and Telesat Canada, had already demonstrated the ability of satellites and small unattended earth stations to collect water-resources data from remote areas of the U.S. and Canada. ComSatCorp would enter the field by acquiring at a price not to exceed $20 million Environmental Research & Technology, Inc. (ERT), currently engaged in a broad spectrum of environmental services. Adding ERT's expertise in environmental data collection, monitoring, analysis, and prediction to ComSatCorp's expertise in satellite communications and related technologies should make the organization better able to extend satellite-communications technology to the growing environmental-information services market.

ComSatCorp had also been working to apply advanced technology in developing and manufacturing specialized products, including earth-station components, signal-processing systems equipment, and fiber-optics communications equipment. (COMSAT annl rept 78, 1-7)

- The Aerospace Industries Assn. announced that industry sales, earnings, backlog, export performance, and contribution to the U.S. balance of trade had improved substantially in 1978. Sales, at $37.3 billion, were up almost $5 billion over 1977; the major gain was in commercial sales. The high inflation rate had distorted sales data, but 1978 sales had increased about 15% above 1977, well in excess of the inflation rate. Industry profits as a percentage of sales rose half a percentage point to 4.7%.

Aerospace exports had reached an all-time high of $9.3 billion, $1.8 billion more than in 1977. At a time when export sales were important to the U.S. economy, the aerospace industry recorded an international trade surplus of nearly $8.4 billion, leading all U.S. manufacturing industries in contributing to the nation's balance of trade. Industry backlog at year-end, estimated at $51.4 billion, was a sharp increase over $44.3 billion in 1977, resulting mostly from a surge of new orders for commercial transports. (*Aerospace*, Winter 78, 2)

Appendix A

SATELLITES, SPACE PROBES, AND MANNED SPACEFLIGHTS, 1978

World space activity in 1978, 125 launches, matched that of 1977; however, the U.S. increased launches from 24 to 32, including *Pioneer Venus 1* (an orbiter) and *2* (four probes and a transporter bus). The USSR decreased launches from 98 to 89 including a Vertikal geophysics probe, with 121 payloads, 96 in the Cosmos series. These included such specialized spacecraft as seven navigation satellites (*Cosmos 991, 994, 996, 1000, 1011, 1027,* and *1046*) and four octuple-payload launches to improve tactical communications. The Soviets also launched six spacecraft in the Molniya comsat series; one Intercosmos spacecraft carrying experiments from other countries; the magnetospheric investigator *Prognoz 7*; two Venus exploration spacecraft, *Venera 11* and *12;* and five manned Soyuz spacecraft of which *Soyuz 28* carried the first Czech cosmonaut, *Soyuz 30* the first Polish cosmonaut, and *Soyuz 31* the first GDR cosmonaut.

In 1978, other countries launched or sponsored six satellites. On Jan. 26 China launched *China 8*, recovered in Feb. In Feb., Japan launched *Exos 1* as part of the International Magnetospheric Study and *ISS 2* (*Ume*), an ionosphere sounder; in Apr. *BSE,* nicknamed *Yuri,* was launched by NASA to experiment with direct-broadcast TV transmission-and-reception technology; and in Sept. *Exos 2*, another magnetosphere-research satellite. NASA launched *Anik 4* in Dec. for Canada's domestic comsat system.

Sources of these data include the United Nations Public Registry of Space Flights; the *Satellite Situation Report* compiled by Goddard Space Flight Center's Operations Control Center; and press releases of NASA, Department of Defense, National Oceanic and Atmospheric Administration, and other government agencies, as well as the Communications Satellite Corporation. Soviet data come from statements in the Soviet press, translations from the Foreign Broadcast Information Service (FBIS), international news service reports, and announcements and briefings by Soviet officials. Data on satellites of other nations also come from the announcements of their respective governments and international news services.

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SATELLITES, SPACE PROBES, AND MANNED SPACEFLIGHTS, 1978

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle, Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Jan. 6	*Cosmos 974* USSR 1978-1A A-2 Plesetsk	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	356	188	89.6	62.8	Reentered Jan. 19. Redundant maneuvering engine separated on Jan. 18; designated 1978-01D.
Jan. 7	*Intelsat IVA F-3* U.S. 1978-2A Atlas-Centaur ETR	Total weight: 1515kg. Objective: To provide 6250 two-way voice circuits plus two television channels simultaneously or a combination of telephone, TV, and other forms of communication traffic. Description: Cylinder 6.99m high, 2.38m in diameter; two main elements: rotating cylinder covered with solar cells contains power subsystem and positioning and orientation subsystems; despun earth-oriented platform atop rotating cylinder contains communications repeaters (transponders), new antenna reflectors, and telemetry and command subsystems.	35 806	35 768	1436.1	0.3	Launched by NASA for ComSatCorp.; fifth in a series of improved Intelsat IVA spacecraft with almost two-thirds greater communications capacity than Intelsat IV model.
Jan. 10	*Soyuz 27* USSR 1978-3A A-2 Baykonur-Tyuratam	Total weight: 6570kg? Objective: Carry a crew to *Salyut 6* orbiting laboratory. Description: Unavailable.	237 350	190 330	88.7 91.3	51.7 51.6	Carried Lt. Col. Vladimir Dzanibekhov and civilian engineer Oleg Makarov; crew returned Jan. 16 in *Soyuz 26* vehicle used by occupants Yuri Romanenko and Georgy Grechko.
Jan. 10	*Cosmos 975* USSR 1978-4A A1 Plesetsk	Total weight: 3800kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	680	637	97.6	81.2	Probable Soviet electronic ferret.

Jan. 10	*Cosmos 976* USSR 1978-5A C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1465	1457	115.1	74.03	Multiple launch (8 satellites) probably for military communications.
	Cosmos 977 USSR 1978-5B C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1465	1403	114.5	74.03	
	Cosmos 978 USSR 1978-5C C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1465	1421	114.7	74.03	
	Cosmos 979 USSR 1978-5D C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1465	1440	115.0	74.03	
	Cosmos 980 USSR 1978-5E C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1478	1465	115.4	74.03	
	Cosmos 981 USSR 1978-5F C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1498	1465	115.6	74.03	

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle, Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Jan. 10	*Cosmos 982* USSR 1978-5G C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1518	1465	115.8	74.03	
	Cosmos 983 USSR 1978-5H C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1540	1465	116.1	74.03	
Jan. 13	*Cosmos 984* USSR 1978-6A A-2 Plesetsk	Total weight: 5700kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	313	215	89.5	62.8	Probable Soviet military photoreconnaissance satellite; recovered Jan. 26.
Jan. 17	*Cosmos 985* USSR 1978-7A C-1 Plesetsk	Total weight: 700kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1032	960	105.0	82.9	Probable Soviet navsat.
Jan. 20	*Progress 1* USSR 1978-8A A-2 Baykonur-Tyuratam	Total weight: 7020kg? Objective: Ferry fuel and materials to *Salyut 6* and remove waste materials; test backup rendezvous system; and perform a small orbital adjustment on the triple spacecraft complex. Description: Unavailable.	348	329	91.3	51.6	Design, though based on the Soyuz craft, did not carry a heat shield; burned up on reentry over Pacific, Feb. 8.

Jan. 24	*Molniya 3J* USSR 1978-9A A-2e Plesetsk	Total weight: 1890kg? Objective: Communications. Description: Unavailable.	40 631	661	736	62.8	For transmitting television programs and multichannel radio communications.
	Cosmos 986 USSR 1978-10A A-2 Baykonur-Tyuratam	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	341	179	89.4	65	Probable Soviet military photoreconnaissance satellite; recovered Feb. 7.
Jan. 26	*China 8* China 1978-11A (No data on vehicle) Shuang-Cheng-Tze	Total weight: 3600kg? Objective: Unavailable. Description: Unavailable.	479	161	90.9	57.0	Reentered Feb. 7; recovered a portion Jan. 30.
Jan. 26	*IUE 1* U.S. 1978-12A Delta ETR	Total weight: 669kg. Objective: To explore ultraviolet region of spectrum at wave lengths inaccessible to ground-based observers. Description: Octagonal cylinder, 4.3m long, 1.4m dia; 2 solar-cell panels with 4.3m span.	45 888	25 669	1435.7	28.6	On station at 71°W; to be used by scientists from a number of countries; orbit inclined and eccentric, to improve communications with ESA observatory near Madrid.
Jan. 31	*Cosmos 987* USSR 1978-13A A-2 Baykonur-Tyuratam	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	359	183	89.6	62.8	Probable Soviet military photoreconnaissance satellite; recovered Feb. 14.
Feb. 4	*Exos 1 (Kykko)* Japan 1978-14A Mu-3H Kagoshima Space Center	Total weight: 103kg. Objective: Part of Japan's contribution to the Intl. Magnetospheric Study. Description: Unavailable.	3977	642	134	65.4	Designed for aurora research; launched by Institute of Space and Aeronautical Science, University of Tokyo.

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle, Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Feb. 8	*Cosmos 988* USSR 1978-15A A-2 Plesetsk	Total weight: 5900kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	363	210	89.9	72.8	Probable Soviet military photoreconnaissance satellite; recovered.
	Pickaback USSR 1978-15F A-2 Plesetsk	Total weight: 200kg? Objective: Unannounced. Description: Unavailable.	335	201	89.9	72.5	
Feb. 9	*FltSatCom 1* U.S. 1978-16A Atlas-Centaur ETR	Total weight: 1884kg (incl. fuel). Objective: Provide communications between ships/military field units using small mobile terminals. Description: Dual hexagon composed of a payload module and spacecraft module.	35 666	35 523	1426.3	2.1	First of four planned comsats to be launched by NASA for U.S. Navy and the Dept. of Defense.
Feb. 14	*Cosmos 989* USSR 1978-17A A-2 Baykonur-Tyuratam	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	354	178	89.5	65	Probable Soviet military photoreconnaissance satellite; recovered Feb. 28.
Feb. 16	*Iss 2 (Ume)* Japan 1978-18A N rocket Tanegashima Space Center	Total weight: 140kg? Objective: Ionosphere research. Description: Unavailable.	1225	972	107	69.4	Ionosphere-sounding satellite launched by Natl. Space Development Agency of Japan.
Feb. 17	*Cosmos 990* USSR 1978-19A C-1 Plesetsk	Total weight: 750kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	824	783	101	74	Probable Soviet military comsat using store/dump technique.

Feb. 22	*Navstar 1* U.S. 1978-20A Atlas F WTR	Total weight: 433kg. Objective: To support USN Global Positioning System. Description: Irregular cylinder with 4 extended solar panels and complex of antennas.	20 308	20 095	718.7	63.3	Launched by USAF.
Feb. 25	*Satellite Data System 6 (Sds 6)* U.S. 1978-21A Titan IIIB-Agena WTR	Total weight: 700kg. Objective: "Development of spaceflight techniques and technology." Description: Unavailable.	39 377	311	703.7	63.2	Launched by USAF for communications.
Feb. 28	*Cosmos 991* USSR 1978-22A C-1 Plesetsk	Total weight: 680kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1022	972	104.8	83	Probable Soviet third-generation navsat.
Mar. 2	*Soyuz 28* USSR 1978-23A A-2 Baykonur-Tyuratam	Total weight: 6570kg? Objective: To carry the third crew to *Salyut 6*. Description: Unavailable.	246 353	192 334	88.8 91.4	51.6 51.6	Carried Col. Aleksey Gubarev and first non-Soviet, non-American to fly in space: Captain Vladimir Remek of the Czech Army; docked Mar. 3, returned to earth March 10.
	Molniya 1-39 USSR 1978-24A A-2e Plesetsk	Total weight: 1750kg? Objective: Communications. Description: Unavailable.	40 733	632	738	62.8	Carried instruments for transmitting television programs and multichannel radio communications.
Mar. 4	*Cosmos 992* USSR 1978-25A A-2 Baykonur-Tyuratam	Total weight: 5700kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	346	210	89.8	71.4	Probable Soviet military photoreconnaissance satellite; recovered Mar. 17.

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle, Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Mar. 5	*Landsat 3* U.S. 1978-26A Delta WTR	Total weight: 960kg. Objective: To acquire multispectral imagery over the U.S. and foreign countries, improve remote-sensing interpretive techniques. Description: Basic structure and design as Nimbus satellites: 3.04m high, 1.52m diameter, 3.96m with solar panels deployed; carried 5-channel multispectral scanner (MSS), a 2-camera return-beam vidicon (RBV), a data-collection system (DCS), and two wideband video tape recorders (WBVTR); satellite capable of near-global coverage.	917	898	103.2	99.1	Launched into circular near-polar sun-synchronous orbit, allowing spacecraft to photograph nearly entire globe during an 18-day period.
	Oscar 8 U.S. 1978-26B Delta WTR	Total weight: 27kg. Objective: To provide continuous radio communications with small amateur ground terminals. Description: Rectangular, covered by solar cells; carried two transponders, only one to be used at a time because of power limitation.	915	904	103.2	99.0	Launched by NASA with *Landsat 3* as secondary payload, replacement for *Oscar 6*; cooperative effort by U.S., Canada, Japan, and West Germany.
	DOD spacecraft U.S. 1978-26C Delta WTR	Total weight: 350kg. Objective: "Develop spaceflight techniques and technology." Description: Unavailable.	913	906	103.2	99.0	Plasma-interaction experiment (PIX).
Mar. 10	*Cosmos 993* USSR 1978-27A A-2 Plesetsk	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	368	182	89.7	72.9	Recovered Mar. 23; maneuvering engine separated Mar. 22, 1978, designated 1978-27D.

Mar. 15	*Cosmos 994* USSR 1978-28A C-1 Plesetsk	Total weight: 680kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1023	996	105	82.9	Probable Soviet second-generation "A" navsat.
Mar. 16	DOD spacecraft U.S. 1978-29A Titan IIID WTR	Total weight: 13 300kg. Objective: "Develop spaceflight techniques and technology." Description: Unavailable.	240	160	88.5	96.4	Reconnaissance satellite (Big Bird 14?) launched by USAF; decayed September 11, 1978.
	Hitchhiker 40 U.S. 1978-29B Titan IIID WTR	Total weight: 60kg. Objective: "Develop spaceflight techniques and technology." Description: Unavailable.	645	639	97.6	95.8	Supplementary payload launched with 1978-29A.
Mar. 17	*Cosmos 995* USSR 1978-30A A-2 Plesetsk	Total weight: 5700kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	262	221	89.1	81.4	Probable Soviet military photoreconnaissance satellite; recovered Mar. 30.
Mar. 28	*Cosmos 996* USSR 1978-31A C-1 Plesetsk	Total weight: 680kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1020	970	104.8	82.9	Probable Soviet third-generation "B" navsat.
Mar. 30	*Cosmos 997* USSR 1978-32A D-1 Baykonur-Tyuratam	Total weight: 9500kg? Objective: A precursor launch, possibly to test reentry. Description: Unavailable.	230	200	88.7	51.6	Two satellites launched on single vehicle, probably recovered at end of first orbit Mar. 30; flight similar to that of Cosmos 881 and 882; possible connection with Cosmos 929.
	Cosmos 998 USSR 1978-32B D-1 Baykonur-Tyuratam	Total weight: 9500kg? Objective: A precursor launch, possibly to test reentry. Description: Unavailable.	230	200	88.7	51.6	

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle, Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Mar. 30	*Cosmos 999* USSR 1978-33A A-2 Baykonur-Tyuratam	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	376	180	89.9	71.4	Probable Soviet military photoreconnaissance satellite; recovered Apr. 12.
Mar. 31	*Cosmos 1000* USSR 1978-34A C-1 Plesetsk	Total weight: 7000kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1024	978	104.9	83	Probable Soviet 4th-generation "B" (civil) navsat.
	Intelsat IVA F-6 U.S. 1978-35A Atlas-Centaur ETR	Total weight: 1500kg. Objective: U.S. commercial comsat. Description: Cylindrical, 6.99m high, 2.4m diameter, solar-panel height 2.8m; carrying 6250 two-way voice circuits plus two television channels; two-thirds increase in capacity over previous Intelsat series.	35 791	35 781	1436.1	0.0	Sixth and last in a series of Hughes-built improved comsats launched by NASA for ComSatCorp., manager of Intelsat series, for business use in geostationary orbit at 60°E over Indian Ocean.
Apr. 4	*Cosmos 1001* USSR 1978-36A A-2 Baykonur-Tyuratam	Total weight: 7000kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	249	205	88.7	51.6	Might be part of development of manned craft; recovered Apr. 15.
Apr. 6	*Cosmos 1002* USSR 1978-37A A-2 Baykonur-Tyuratam	Total weight: 5500kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	305	209	89.4	65	Probable Soviet military photoreconnaissance satellite; recovered Apr. 19.
Apr. 7	*Rhyolite RH-4* U.S. 1978-38A Atlas-Agena D ETR	Total weight: 700kg. Objective: "Develop spaceflight techniques and technology." Description: Unavailable.	41 411	6528	615.5	28.4	Launched by USAF; probable U.S. early-warning satellite to monitor missile launchings.

Apr. 7	*BSE Yuri* Japan 1978-39A Delta ETR	Total weight: 678kg. Objective: Broadcast color television to remote islands of Japan. Description: Rectangular electronics module 1.3m wide, 1.2m long, 3.9m high, including apogee-boost motor; deployable solar panels 8.9m long, 1.5m wide; three-axis-stabilized.	35 797	35 774	1436.0	0.0	Broadcasting Satellite-Experimental launched by NASA for the Natl. Space Development Agency (NASDA) of Japan, in geostationary orbit at 110°E above the equator south of Japan.
Apr. 20	*Cosmos 1003* USSR 1978-40A A-2 Plesetsk	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	349	185	89.6	62.8	Probable Soviet military photoreconnaissance satellite; recovered May 4.
Apr. 26	*Hcmm (Aem 1)* U.S. 1978-41A Scout WTR	Total weight: 134kg. Objective: Produce thermal maps of earth's atmosphere; investigate use of day/night thermal imagery to generate apparent thermal-inertial and temperature-cycle data. Description: Basic module containing attitude-control, data-handling, communications, command and power subsystems; instrument module containing heat-capacity mapping radiometer (HCMR) and supporting equipment; powered by two solar panels.	626	612	97.1	97.6	Heat-capacity mapping mission also known as Applications Explorer Mission A (AEM-A); first in a series of low-cost modular spacecraft in special orbits for mission-unique experimental data acquisition, to measure earth's surface for maximum temperatures and 12 hrs later for same area's minimum temperature.
May 1	*Ams 3* U.S. 1978-42A Thor-Burner 2 WTR	Total weight: 513kg. Objective: "Develop spaceflight techniques and technology." Description: Similar to NASA's Tiros-N.	835	820	101.3	98.6	Advanced meteorological satellite; launched by USAF to support Defense Meteorological Satellite Program.
May 5	*Cosmos 1004* USSR 1978-43A A-2 Plesetsk	Total weight: 5900kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	311	213	89.4	62.8	Probable Soviet military photoreconnaissance satellite; recovered May 18.
	Pickaback USSR 1978-43G A-2 Plesetsk	Total weight: 200kg? Objective: Unavailable. Description: Unavailable.	431	204	90.0	62.8	

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle, Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
May 11	*Ots 2* U.S. 1978-44A Delta ETR	Total weight: 865kg. Objective: Test concepts for satellite links in the 1980s to provide intra-European telephone, telegraph, telex, and television in Western Europe. Description: Six-sided box containing payload module; service module; and antenna assembly, measuring 1.62m wide, 2.39m high, and 9.26m across with solar array deployed; three-axis stabilized.	35 792	35 786	1436.2	0.0	Orbital test satellite launched by NASA for ESA to replace OTS-A, destroyed Sept. 13, 1977, when its launcher exploded.
May 12	*Cosmos 1005* USSR 1978-45A A-1 Plesetsk	Total weight: 3800kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	672	626	97.6	81.2	Probable Soviet military electronic ferret.
	Cosmos 1006 USSR 1978-46A C-1 Plesetsk	Total weight: 900kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	417	383	92.5	65.8	Probable Soviet radar-calibration satellite.
May 13	*NavStar 2* U.S. 1978-47A Atlas F WTR	Total weight: 433kg. Objective: To support USN Global Positioning System. Description: Irregular cylinder with four extended solar panels and complex of antennas.	20 084	19 952	711.3	63.1	Launched by USAF.
May 16	*Cosmos 1007* USSR 1978-48A A-2 Plesetsk	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	384	180	89.8	72.9	Probable Soviet military photoreconnaissance satellite; recovered May 29.

May 17	*Cosmos 1008* USSR 1978-49A C-1 Plesetsk	Total weight: 975kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	551	501	95.1	74	Probable Soviet military electronic ferret.
May 19	*Cosmos 1009* USSR 1978-50A F-1m Baykonur-Tyuratam	Total weight: 3320kg? Objective: First test of new hunter-killer satellite, 15th test since program began in 1968. Description: Unavailable.	1378	971	109	66	Satellite interceptor made close approach to orbiting *Cosmos 967*; plunged into Pacific May 19.
May 20	*Pioneer Venus 1* U.S. 1978-51A Atlas-Centaur ETR	Total weight: 549kg. Objective: Determine structure of upper atmosphere and ionosphere of Venus; observe interaction of solar wind with Venus ionosphere and with the small magnetic field; use remote sensing to observe characteristics of atmosphere and surface of Venus on a planetary scale; measure planet's gravitational field; detect gamma-ray bursts. Description: Cylinder 1.2m high, 4.5m including antenna mast, 2.5m in diameter, powered by solar cells on spacecraft exterior and 2 nickel-cadmium batteries.	(Currently in heliocentric orbit)				First of 2 NASA interplanetary s/c; scheduled to arrive at Venus Dec. 78, measure planet atmosphere and electromagnetic environment from orbit.
May 23	*Cosmos 1010* USSR 1978-52A A-2 Plesetsk	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	257	218	89	81.4	Probable Soviet earth-resources observation satellite; recovered June 5.
	Cosmos 1011 USSR 1978-53A C-1 Plesetsk	Total weight: 680kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1026	978	104.9	82.9	Probable Soviet third-generation "B" navsat.
May 25	*Cosmos 1012* USSR 1978-54A A-2 Plesetsk	Total weight: 5700kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	280	214	89.2	62.8	Probable Soviet military photoreconnaissance satellite; recovered June 7.

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle, Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
June 2	*Molniya 1-40* USSR 1978-55A A-2e Plesetsk	Total weight: 1750kg? Objective: Transmit TV programs and multichannel radio communications. Description: Unavailable.	40 837	457	736	62.5	
June 7	*Cosmos 1013* USSR 1978-56A C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1555	1480	116.3	74.0	Multiple launch (8 satellites) probably for Soviet military communications.
	Cosmos 1014 USSR 1978-56B C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1533	1480	116.1	74.0	
	Cosmos 1015 USSR 1978-56C C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1518	1475	115.8	74.0	
	Cosmos 1016 USSR 1978-56D C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1500	1472	115.6	74.0	
	Cosmos 1017 USSR 1978-56E C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1494	1459	115.4	74.0	

June 7	*Cosmos 1018* USSR 1978-56F C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1490	1443	115.2	74.0	
	Cosmos 1019 USSR 1978-56G C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1491	1424	115.0	74.0	
	Cosmos 1020 USSR 1978-56H C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1456	1409	114.8	74.0	
June 10	*Cosmos 1021* USSR 1978-57A A-2 Baykonur-Tyuratam	Total weight: 6000kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	336	180	89.4	65	Probable Soviet military photoreconnaissance satellite; recovered June 23.
	Imews 8 U.S. 1978-58A Titan IIID WTR	Total weight: 820kg. Objective: "Development of spaceflight techniques and technology." Description: Unavailable.	42 039	29 929	1446.3	12.0	Launched by USAF as part of integrated missile early-warning system.
June 12	*Cosmos 1022* USSR 1978-59A A-2 Plesetsk	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	374	182	89.7	72.9	Probable Soviet military photoreconnaissance satellite; recovered June 25.
June 14	*Kh-11-2* U.S. 1978-60A Titan IIID WTR	Total weight: 13 300kg. Objective: "Develop spaceflight techniques and technology." Description: Unavailable.	509	276	92.4	96.8	"Big Bird" reconnaissance satellite launched by USAF.

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle, Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
June 15	*Soyuz 29* USSR 1978-61A A-2 Baykonur-Tyuratam	Total weight: 6570 kg? Objective: Carry crew to *Salyut 6.* Description: Unavailable.	355	339	91.4	51.6	*Soyuz 29* crew (Col. Vladimir Kovalenok, civilian engr. Aleksandr Ivanchenkov) docked with *Salyut 6's* forward docking port June 16/78; returned to earth Sept. 3.
June 16	*Goes 3* U.S. 1978-62A Delta ETR	Total weight: 627kg. Objective: Continuous observation of earth's atmosphere. Description: Cylinder 190.5cm in diameter, 344cm long from top of magnetometer to bottom of apogee boost motor; primary member, thrust tube located in the center of cylinder, contains radiometer/telescope extending length of spacecraft; scanning mirror looks out through an opening in cylindrical solar arrays.	35 804	35 776	1436.2	0.7	Third of a series of geostationary operational environmental satellites launched by NASA for NOAA; on station at 135°W.
June 21	*Cosmos 1023* USSR 1978-63A C-1 Plesetsk	Total weight: 750kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	822	784	100.8	74.1	Probable Soviet military comsat using data-store/dump techniques.
June 27	*SeaSat 1* U.S. 1978-64A Atlas Agena D WTR	Total weight: 2300kg. Objective: Experimental satellite to demonstrate microwave monitoring of ocean surface. Description: Two major hardware elements: Agena bus for launch function and satellite support (attitude control, power, guidance, telemetry, and command); sensor module, platform for five sensors, antennas, laser retroflector, tracking aids, and a SAR downlink. Two modules combined length 21m, maximum diameter 1.5m without antennas.	800	776	100.6	108.0	All sensors turned on simultaneously July 7; spacecraft ceased transmitting Oct. 9; attempts to reestablish contact unsuccessful.

June 27	*Soyuz 30* USSR 1978-65A A-2 Baykonur-Tyuratam	Total weight: 6570kg? Objective: To carry additional crew to *Salyut 6.* Description: Unavailable.	244 360	194 336	88.8 91.2	51.6 51.6	Carried second international crew to join *Soyuz 29* crew on *Salyut 6* (flight engineer Major Miroslaw Hermaszewski of Polish Air Force and Lt. Col. Pyotr Klimuk); docked with aft port of *Salyut 6* June 28/78; returned to earth July 5.
June 28	*Cosmos 1024* USSR 1978-66A A-2e Plesetsk	Total weight: 1800kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	40 000	630	726	62.8	Probable Soviet early-warning satellite.
	Cosmos 1025 USSR 1978-67A F-2 Plesetsk	Total weight: 6320kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	680	649	97.8	82.5	Possible Soviet electronic scanner of ocean surface.
June 29	*Comstar 3* U.S. 1978-68A Atlas-Centaur ETR	Total weight: 1520kg. Objective: Provide 14 000 two-way domestic high-quality voice circuits (telephone). Description: Cylinder, 610cm high, 244cm in diameter; 14 000 solar cells on exterior; nickel-cadmium batteries to provide power during launch and twice-a-year solar eclipses.	35 789	35 783	1436.1	0.0	Launched by NASA for Comsat General Corp.
July 2	*Cosmos 1026* USSR 1978-69A A-2 Baykonur-Tyuratam	Total weight: 5700kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	261	209	89	51.8	Probable Soviet military photoreconnaissance satellite; recovered July 6.
July 7	*Progress 2* USSR 1978-70A A-2 Baykonur-Tyuratam	Total weight: 7020kg. Objective: Unmanned supply craft carrying consumables to *Salyut 6.* Description: Unavailable.	309	248	90.0	51.6	Docked with *Salyut 6* July 9; burned up over Pacific Aug. 4.

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle, Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
July 14	*Geos 2* U.S. 1978-71A Delta ETR	Total weight: 573kg. Objective: Scientific studies of earth's magnetosphere. Description: Cylinder 1.6m dia, 1.1m high, covered with solar cells; eight booms varying in length between 1.5 and 2.0m.	35 789	35 784	1436.0	0.5	Launched by NASA for ESA to perform same experiments as *Geos 1*, which failed to achieve satisfactory orbit in Apr. 77.
	Molniya 1-41 USSR 1978-72A A-2e Plesetsk	Total weight: 1750kg? Objective: Provide TV and multichannel radio transmissions. Description: Unavailable.	40 660	650	737	62.8	
July 18	*Raduga 4* USSR 1978-73A D-1e Baykonur-Tyuratam	Total weight: 2500kg? Objective: Provide telephone and telegraph links, TV transmissions. Description: Unavailable.	35 590	36 590	1478	0.5	In geostationary orbit at stationary position over Indian Ocean.
July 27	*Cosmos 1027* USSR 1978-74A C-1 Plesetsk	Total weight: 680kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1015	979	104.8	82.9	Probable Soviet second-generation "A" navsat.
Aug. 5	Satellite Data System *Sds7* U.S. 1978-75A Tital IIIB WTR	Total weight: 700kg. Objective: "Development of spaceflight techniques and technology." Description: Unavailable.	39 315	380	703.8	63.3	DOD comsat launched by USAF.
	Cosmos 1028 USSR 1978-76A A-2 Plesetsk	Total weight: 6700kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	272	182	88.7	67.1	Probable Soviet military photoreconnaissance satellite; recovered Sept. 4.

Aug. 7	*Progress 3* USSR 1978-77A A-2 Baykonur-Tyuratam	Total weight: 7020kg. Objective: Carry food supplies to *Salyut 6* crew (*Soyuz 29*). Description: Unavailable.	249	195	88.7	51.6	Docked with *Salyut 6* Aug. 10; reentered over the Pacific Aug. 23.
Aug. 8	*Pioneer Venus 2* U.S. 1978-78A Atlas Centaur ETR	Total weight: 904kg. Objective: Carry sounders and bus to measure nature and composition of clouds, composition and structure of atmosphere and general atmosphere circulation pattern of Venus. Description: Cylindrical bus carrying four atmospheric-entry probes: height, top of main probe to bottom of bus, 2.9m; diameter, 2.5m. Four probes carried on bus by a large inverted cone structure, three small probes equally spaced around larger probe in center.	(Currently in heliocentric orbit)				Large probe separated from bus Nov. 15, three smaller probes separated Nov. 20. Four probes reached Venus surface; bus burned up in atmosphere; one probe transmitted data for an hour after impact.
Aug. 12	*Isee 3* U.S. 1978-79A Delta ETR	Total weight: 469kg. Objective: Measure interaction between solar wind and earth. Description: 16-sided cylinder, 173cm dia, 161cm high; solar array located forward of equipment section, another below; instruments mounted on equipment shelf.	1 151 664	180	73 702	28.9	Third of three intl. sun-earth explorers; to be inserted into halo orbit (around a Lagrange point) in Nov.
Aug. 22	*Molniya 1-42* USSR 1978-80A A-2e Plesetsk	Total weight: 1750kg. Objective: Transmit TV and multichannel radio communications. Description: Unavailable.	40 788	480	736	62.8	Forty-second operational Molniya-1 comsat.
Aug. 26	*Soyuz 31* USSR 1978-81A A-2 Baykonur-Tyuratam	Total weight: 6570kg? Objective: Carry crew to *Salyut 6.* Description: Unavailable.	243	193	88.8	51.6	Carried third international crew to join *Soyuz 29* crew on *Salyut 6* (including Col. Valery Bykovsky and Sigmund Jähn of the GDR). *Soyuz 31* crew returned in *Soyuz 29* vehicle Sept. 3.

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle, Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Aug. 29	*Cosmos 1029* USSR 1978-82A A-2 Plesetsk	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	353	186	89.6	62.8	Probable Soviet military photoreconnaissance satellite; fragment separated from *Cosmos 1029* Sept. 7 roughly spheric, recovered Sept. 11 near Moulins, France.
Sept. 6	*Cosmos 1030* USSR 1978-83A A-2e Plesetsk	Total weight: 1800kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	40 100	650	725.6	62.8	Probable Soviet early-warning satellite.
Sept. 9	*Venera 11* USSR 1978-84A D-1e Baykonur-Tyuratam	Total weight: 4940kg? Objective: Explore Venus. Description: Unavailable.	Heliocentric orbit				First of two Venus-exploration craft launched during 1978 window for Venus encounter (arrived Dec. 25, 1978).
	Lander USSR 1978-84E D-1e Baykonur-Tyuratam	Total weight: 1560kg? Objective: Soft landing on Venus. Description: Unavailable.					
	Cosmos 1031 USSR 1978-85A A-2 Plesetsk	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	351	191	89.6	62.8	Probable Soviet military photoreconnaissance satellite; recovered Sept. 22.
Sept. 14	*Venera 12* USSR 1978-86A D-1e Baykonur-Tyuratam	Total weight: 4940kg? Objective: Explore Venus. Description: Unavailable.	Heliocentric orbit				Second Venus-exploration craft.

Sept. 14	*Lander* USSR 1978-86E D-1e Baykonur-Tyuratam	Total weight: 1560kg? Objective: Venus landing. Description: Unavailable.					
Sept. 16	*Exos 2* Japan 1978-87A Mu-3H Kagoshima	Total weight: 100kg. Objective: Magnetosphere research. Description: Unavailable.	30 051	228	523.17	31.1	Japanese research satellite, also known as Jiki-Ken (magnetosphere).
Sept. 19	*Cosmos 1032* USSR 1978-88A A-2 Plesetsk	Total weight: 5900kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	249	218	88.9	81.4	Probable Soviet military photoreconnaissance satellite; recovered Oct. 3.
Oct. 3	*Cosmos 1033* USSR 1978-89A A-2 Plesetsk	Total weight: 5900kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	268	223	89.1	81.4	Probable Soviet photoreconnaissance satellite carrying earth-resources equipment; recovered Oct. 16.
	Progress 4 USSR 1978-90A A-2 Baykonur-Tyuratam	Total weight: 7020kg? Objective: Unmanned supply vehicle carrying fuel and other consumables to *Soyuz 29* crew aboard *Salyut 6*. Description: Unavailable.	266 362	191 359	88.8 91.7	51.7 51.6	Docked at *Salyut 6* aft port Oct. 6; refueling completed Oct. 13; on Oct. 20 Progress engines boosted *Soyuz 31-Salyut 6-Progress 4* orbit; undocked Oct. 24; reentered Oct. 26.
Oct. 4	*Cosmos 1034* USSR 1978-91A C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1479	1421	115.0	74	Multiple launch (probable military comsats), 8 on single launcher.
	Cosmos 1035 USSR 1978-91B C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1478	1401	114.7	74	

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle, Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Oct. 4	*Cosmos 1036* USSR 1978-91C C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1479	1440	115.2	74	
	Cosmos 1037 USSR 1978-91D C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1480	1459	115.4	74	
	Cosmos 1038 USSR 1978-91E C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1485	1475	115.6	74	
	Cosmos 1039 USSR 1978-91F C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1550	1477	116.4	74	
	Cosmos 1040 USSR 1978-91G C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1525	1477	116.1	74	
	Cosmos 1041 USSR 1978-91H C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1507	1475	115.9	74	

Oct. 6	*Cosmos 1042* USSR 1978-92A A-2 Plesetsk	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	326	187	89.3	62.8	Probable Soviet military photoreconnaissance satellite; recovered Oct. 19.
Oct. 7	*Navstar 3* U.S. 1978-93A Atlas F WTR	Total weight: 433kg. Objective: Support DOD's Global Positioning System. Description: Irregular cylinder, 4 extended solar panels, and complex of antennas.	20 312	20 285	722.6	62.8	Launched by USAF.
Oct. 10	*Cosmos 1043* USSR 1978-94A A-1 Plesetsk	Total weight: 3800kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	650	625	97.3	81.1	Probable Soviet military intelligence electronic ferret.
Oct. 13	*Molniya 3-10* USSR 1978-95A A-2e Plesetsk	Total weight: 1890kg? Objective: Domestic comsat carrying radio, TV, telephone, telegraph equipment. Description: Unavailable.	40 825	467	736	62.8	Probable replacement for *Molniya 3-6* (1976-127A).
	Tiros N U.S. 1978-96A Atlas F WTR	Total weight: 734kg. Objective: Provide real-time meteorological information. Description: Spacecraft, adapted from RCA's 1976 Tiros, 371cm high, 188cm dia; solar panel deployed in orbit.	866	850	102.1	98.9	Launched by NASA; turned over to NOAA Nov 6. First of 8 planned third-generation operational polar-orbiting meteosats; primary data source for Global Atmospheric Research Program's Global Weather Experiment, intl. cooperative program.
Oct. 17	*Cosmos 1044* USSR 1978-97A A-2 Plesetsk	Total weight: 5700kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	315	211	89.5	62.8	Probable Soviet military photoreconnaissance satellite, recovered Oct. 30.
Oct. 24	*Nimbus 7* U.S. 1978-98A Delta WTR	Total weight: 987kg. Objective: Pollution monitoring. Description: Butterfly-shaped in orbit; 3m high, 2m wide; earth-oriented, three-axis-stabilized.	955	943	104.1	99.3	Last of Nimbus meteosats series first launched in 1964; first satellite designed to monitor atmosphere for manmade and natural pollutants.

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle, Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Oct. 24	*Cameo* U.S. 1978-98B Delta WTR	Total weight: 350kg. Objective: Study solar energy, plasma flows and electric fields in Arctic regions.	953.0	933.0	103.9	99.2	Chemically active materials ejected in orbit, piggyback payload with *Nimbus 7*, activated four barium canisters over northern Alaska, lithium canister over Scandinavia.
	Intercosmos 18 USSR 1978-99A C-1 Plesetsk	Total weight: 550kg? Objective: Study magnetosphere and ionosphere. Description: Unavailable.	644	378	96.5	82.9	International cooperative mission supported by USSR, Czechoslovakia, Hungary, Poland, and Romania.
	Magion Czechoslovakia 1978-99C C-1 Plesetsk	Total weight: 15kg? Objective: Study magnetosphere and ionosphere. Description: Unavailable.	667	383	95.1	82.9	Czechoslovakian satellite, part of *Intercosmos 18* scientific mission; separated into autonomous orbit Nov. 14.
	Cosmos 1045 USSR 1978-100A F-2 Plesetsk	Total weight: 3400kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1704	1682	120.3	82.5	Probable Soviet earth-resources satellite for sea-surface scanning.
Oct. 26	*Radio 1* USSR 1978-100B F-2 Plesetsk	Total weight: 40kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1705	1682	120.3	82.5	Carried equipment to improve amateur (ham) radio communications, as well as student experiments.
	Radio 2 USSR 1978-100C F-2 Plesetsk	Total weight: 40kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1704	1682	120.3	82.6	See *Radio 1*.

Oct. 30	*Prognoz 7* USSR 1978-101A A-2e Baykonur-Tyuratam	Total weight: 910kg? Objective: Scientific satellite to study magnetosphere, carrying instruments for ultraviolet and gamma-radiation research. Description: Unavailable.	202 965	483	5888.0	65.0	Onboard equipment manufactured in Hungary, Sweden, France, Czechoslovakia, and USSR.
Nov. 1	*Cosmos 1046* USSR 1978-102A A-2 Plesetsk	Total weight: 5900kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	353	212	89.9	72.9	Probable Soviet military photoreconnaissance satellite; recovered Nov. 14.
Nov. 3	*Vertikal 7* USSR C rocket Kapustin Yar	Total weight: 1300kg? Objective: Geophysical probe; research on ionosphere and shortwave radiation. Description: Unavailable.	1500 altitude (instrument pkg separated at 175 km)				Onboard equipment made in USSR, Bulgaria, Romania, Hungary, and Czechoslovakia.
Nov. 13	*Heao 2* U.S. 1978-103A Atlas-Centaur ETR	Total weight: 2720kg. Objective: High-energy astronomical observatory to detect x-rays from objects two-thirds of the way toward the edge of the universe. Description: Octagonal prism 9m long, 3m dia.	545	525	95.3	23.5	Second of three NASA high-energy astronomical observatories; this mission would concentrate on findings of *Heao 1*.
Nov. 15	*Cosmos 1047* USSR 1978-104A A-2 Plesetsk	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	378	182	89.8	72.9	Probable Soviet military photoreconnaissance satellite; recovered Nov. 28.
Nov. 16	*Cosmos 1048* USSR 1978-105A C-1 Plesetsk	Total weight: 750kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	824	788	101	74	Probable Soviet military comsat using data-store/dump techniques.
Nov. 18	*NATO 3C* U.S. 1978-106A Delta ETR	Total weight: 701kg. Objective: Defense communications. Description: Drum 2.18m in dia, 2.23m long, cylindrical solar array; spin-stabilized.	35 814	35 460	1428.5	4.3	Third advanced NATO comsat, serving as backup for *NATO 3A* and *3B*; on station at 50°W over Atlantic.

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle, Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Nov. 21	*Cosmos 1049* USSR 1978-107A A-2 Plesetsk	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	375	183	89.7	72.9	Probable Soviet military photoreconnaissance satellite; recovered Dec. 4.
Nov. 28	*Cosmos 1050* USSR 1978-108A A-2 Plesetsk	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	298	258	89.8	62.8	Probable Soviet military photoreconnaissance satellite; recovered Dec. 11.
Dec. 5	*Cosmos 1051* USSR 1978-109A C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1484	1392	114.6	74.0	Multiple launch (8 comsats) on single launcher.
	Cosmos 1052 USSR 1978-109B C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1487	1409	114.8	74.0	
	Cosmos 1053 USSR 1978-109C C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1487	1427	115.0	74.0	
	Cosmos 1054 USSR 1978-109D C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1488	1444	115.2	74.0	

Dec. 5	*Cosmos 1055* USSR 1978-109E Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1489	1462	115.5	74.0	
	Cosmos 1056 USSR 1978-109F C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1502	1470	115.7	74.0	
	Cosmos 1057 USSR 1978-109G C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1513	1479	115.9	74.0	
	Cosmos 1058 USSR 1978-109H C-1 Plesetsk	Total weight: 50kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1536	1479	116.2	74.0	
Dec. 7	*Cosmos 1059* USSR 1978-110A A-2 Plesetsk	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	360	188	89.7	62.8	Probable Soviet military photoreconnaissance satellite; recovered Dec. 20.
Dec. 8	*Cosmos 1060* USSR 1978-111A A-2 Baykonur-Tyuratam	Total weight: 5700kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	311	209	89.5	65	Probable Soviet military photoreconnaissance satellite; recovered Dec. 21.
Dec. 11	*Navstar 4* U.S. 1978-112A Atlas F WTR	Total weight: 433kg. Objective: Support DOD's Global Positioning System. Description: Irregular cylinder, 4 extended solar panels, complex of antennas.	20 316	20 267	722.4	63.3	Fourth satellite in DOD Global Positioning System; launched by USAF.

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle, Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Dec. 14	*Dscs 2-11* U.S. 1978-113A Tital IIIC ETR	Total weight: 590kg. Objective: "Develop spaceflight techniques and technology." Description: Unavailable.	35 796	35 726	1436	2.3	Pair of military comsats launched by USAF.
	Dscs 2-12 U.S. 1978-113B Titan IIIC ETR	Total weight: 590kg. Objective: "Develop spaceflight techniques and technology." Description: Unavailable.	36 413	36 261	1464.3	2.5	
Dec. 14	*Cosmos 1061* USSR 1978-114A A-2 Plesetsk	Total weight: 200kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	333	211	89.6	62.8	Probable Soviet military photoreconnaissance satellite, recovered Dec. 27.
Dec. 15	*Cosmos 1062* USSR 1978-115A C-1 Plesetsk	Total weight: 875kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	548	508	95.1	74.0	Probable Soviet military intelligence electronic ferret.
Dec. 16	*Anik 4* (Telesat D) U.S. 1978-116A Delta ETR	Total weight: 922kg. Objective: Provide transmission of television, voice, and other data throughout Canada. Description: Box 325.9cm long, antenna 112cm, and 217.4cm dia.	35 794	35 782	1436.1	0.0	Second-generation comsat launched by NASA for Canada's Domestic Communications Satellite System.
Dec. 19	*Cosmos 1063* USSR 1978-117A A-1 Plesetsk	Total weight: 3800kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	661	632	97.5	81.2	Probable Soviet military intelligence electronic ferret.

Dec. 19	*Horizont 1* USSR 1978-118A D-1e Baykonur-Tyuratam	Total weight: 2880kg? Objective: Provide telephone and TV communications. Description: Unavailable.	48 365	22 581	1420	11.3	Planned orbit was inclined for better coverage of far north areas; apparently failed to reach planned orbit.
Dec. 20	*Cosmos 1064* USSR 1978-119A C-1 Plesetsk	Total weight: 680kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	991	435	98.7	83	Probable Soviet third-generation "B" navsat; went into wrong orbit.
Dec. 22	*Cosmos 1065* USSR 1978-120A Kapustin Yar	Total weight: 90kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	556	346	93.7	50.7	Probable Soviet radar-calibration satellite.
Dec. 23	*Cosmos 1066* USSR 1978-121A A-1 Plesetsk	Total weight: 3300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	908	848	102.2	81.2	Possibly related to Meteor 2 series of weather satellites; press reported failure.
Dec. 26	*Cosmos 1067* USSR 1978-122A C-1 Plesetsk	Total weight: 600kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	1226	1184	109.2	83	Probable Soviet geodetic-research satellite.
Dec. 26	*Cosmos 1068* USSR 1978-123A A-2 Plesetsk	Total weight: 6300kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	401	187	90.2	62.8	Probable Soviet military photoreconnaissance satellite, recovered Jan. 8, 1979.
Dec. 28	*Cosmos 1069* USSR 1978-124A A-2 Plesetsk	Total weight: 5900kg? Objective: "Continuation of outer space investigations." Description: Unavailable.	290	244	89.8	62.8	Probable Soviet military photoreconnaissance satellite, recovered Jan. 10, 1979.

Appendix B

MAJOR NASA LAUNCHES, 1978

During 1978, the U.S. had 32 launches (with 37 payloads), including two *Pioneer* launches to take pictures and conduct detailed scientific examinations of Venus. Of these, 12 (with 14 payloads) were launches by DOD. The remaining 20 with 23 payloads were NASA launches. Of these, 10 were scientific payloads (including the Cameo barium and lithium-cloud experiment payload carried in the rocket body of the *Nimbus 7* and the interplanetary *Pioneer* launchers).

Payloads launched for others in 1978 included two for DOD (a piggyback classified payload in March and FltSatCom 1 in Feb.); three comsats for ComSatCorp (Intelsat IV-A F-3 in Jan., Intelsat IV-A F-6 in Mar., and *Comstar 3* in June); two for NOAA (*Goes 3* in June and *Tiros N* in Oct.); and six international satellites (in Mar. *Oscar 8*, a cooperative effort by U.S., Canada, Japan, and West Germany; *BSE* for Japan in Apr.; *OTS 2* in May and *Geos 2* in July for ESA; *Nato IIIC* in Nov. for NATO; and *Anik 4* in Dec. for Canada).

These tables usually categorize vehicle and payload performance as S for successful, P for partially successful, or U for unsuccessful. A fourth category (Unk) would indicate payloads that did not operate because of vehicle failure. These categories, which are unofficial, do not take into account that U missions might produce valuable information, or that payloads with a long-life design might later fail to meet the design requirements and might then become officially unsuccessful. Futher information on these launches appears in Appendix A and in the indexed entries in the text.

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MAJOR NASA LAUNCHES, 1978

Date	Name (NASA Code)	General Mission	Launch Vehicle (Site)	Performance		Remarks
				Vehicle	Payload	
Jan. 7	*Intelsat IVA F-3*	To launch satellite into transfer orbit. Satellite to provide 6250 two-way voice circuits plus two television channels simultaneously or a combination of telephone, TV, and other forms of communication traffic.	Atlas-Centaur ETR	S	S	Launched by NASA for ComSatCorp., manager of Intelsat; fifth in a series of improved Intelsat IVA spacecraft with almost two-thirds greater communications capacity than *Intelsat IV* type.
Jan. 26	*IUE 1*	To launch satellite into elliptical geosynchronous orbit; orbiting ultraviolet observatory to investigate stellar atmospheres and interplanetary medium, celestial objects of different galaxies, and quasars.	Delta ETR	S	S	Launched into successful transfer orbit; spacecraft placed above South America.
Feb. 9	*Fltsatcom 1*	To place DOD satellite in successful transfer orbit.	Atlas-Centaur ETR	S	S	First of four planned satellites launched by NASA for the Navy and the Dept. of Defense.
Mar. 5	*Landsat 3*	To acquire multispectral imagery over the U.S. and foreign countries to improve remote-sensing interpretive techniques.	Delta WTR	S	S	Third operational U.S. earth-resources survey satellite, an improved version of *Landsat 1* launched in 1972 and *Landsat 2* placed in orbit in 1975.
	Oscar 8	To place satellite into a sun-synchronous orbit; to provide continuous radio communications with small amateur ground terminals.	Delta WTR	S	S	Latest in a series of satellites for use by amateurs, replacing *Oscar 6*, and launched by NASA as secondary payload with *Landsat 3*.
	DOD spacecraft	Mission not announced.	Delta WTR	S	S	Another secondary payload with *Landsat 3*, launched for DOD.
Mar. 31	*Intelsat IVA F-6*	To launch satellite into successful transfer orbit from which synchronous orbit can be achieved.	Atlas-Centaur ETR	S	S	Sixth and last in a series of improved satellites launched by NASA for ComSatCorp., manager of Intelsat, as a domestic communications satellite in geostationary orbit.

Apr. 7	*Yuri* (BSE)	To launch satellite into synchronous transfer orbit and is designed to conduct experiments in direct broadcast television transmission and reception technology.	Delta ETR	S	S	Japanese Broadcast Satellite-Experimental (Japan/BSE) launched by NASA for the National Space Development Agency (NASDA).
Apr. 26	*HCMM (AEM 1)*	To launch spacecraft into near-earth, circular sun-synchronous orbit to enable instruments to conduct research into the feasibility of using day/night thermal imagery to apparent thermal inertial values and temperature cycle data.	Scout WTR	S	S	*Heat Capacity Mapping Mission (HCMM),* also known as Applications Explorer Mission A (AEM-A), satellite is first in a series to operate in special orbits that satisfy mission-unique experimental data acquisition requirements.
May 11	*OTS 2*	To test concepts to be used in providing satellite links in the 1980s for routing of portions of the intra-European telephone, telegraph, and telex traffic as well as television relay for Western Europe.	Delta ETR	S	S	Launched by NASA for the European Space Agency (ESA) as a replacement for OTS-A, which was destroyed when its launcher exploded on Sept. 13, 1977.
May 20	*Pioneer Venus 1*	To determine the structure of upper atmosphere and ionosphere of Venus, to observe characteristics of atmosphere and surface, to measure gravitational field, and to detect gamma ray bursts.	Atlas-Centaur ETR	S	S	Spacecraft took pictures of Venus and conducted detailed scientific examination of the planet from orbit.
June 16	*GOES 3*	To launch spacecraft into synchronous orbit of sufficient accuracy to enable satellite to provide continuous observations of the earth's atmosphere on an operational basis.	Delta ETR	S	S	Third operational spacecraft of a series of Geostationary Operational Environmental Satellites launched by NASA for NOAA.
June 27	*SeaSat 1*	Experimental ocean satellite designed to determine whether microwave instruments are suitable for measuring the surface conditions of the seas.	Atlas Agena D or Atlas F WTR	S	U	All sensors turned on simultaneously July 7; spacecraft ceased transmitting data Oct. 9, and subsequent attempts to reestablish contact were unsuccessful.
June 29	*Comstar 3*	To provide 14 000 two-way, high-quality voice circuits.	Atlas-Centaur ETR	S	S	Launched by NASA for Comsat General Corp.; U.S. domestic telephone-communications satellite with a design life of seven years.
July 14	*Geos 2*	Designed to make scientific studies of the magnetosphere.	Delta ETR	S	S	Launched by NASA for ESA to perform same experiments as *Geos 1,* which failed to achieve satisfactory orbit.

Date	Name (NASA Code)	General Mission	Launch Vehicle (Site)	Performance		Remarks
				Vehicle	Payload	
Aug. 8	*Pioneer Venus 2*	To determine the nature and composition of clouds of Venus and the composition, structure, and general circulation pattern of the atmosphere.	Atlas-Centaur ETR	S	S	Spacecraft (cylindrical bus carrying four atmospheric entry probes, all of which reached Venus's surface) burned up in Venus atmosphere.
Aug. 12	*ISEE 3*	To obtain detailed measurements of the solar wind and its fluctuations.	Delta ETR	S	S	Third spacecraft in a series of three International Sun-Earth Explorers; inserted into a halo orbit.
Oct. 13	*Tiros N*	To measure temperature and humidity in earth's atmosphere, surface temperature, surface and cloud cover, water-ice-moisture boundaries, and proton and electron flux near earth.	Atlas F WTR	S	S	Launched by NASA for NOAA; first of eight third-generation operational meteorological polar-orbiting spacecraft; primary data source for Global Atmospheric Research Program's Global Weather Experiment, international cooperative program involving some 140 countries.
Oct. 24	*Nimbus 7*	Designed to study the atmosphere's physical characteristics and to search for evidence of both natural and manmade pollutants.	Delta WTR	S	S	Last in a series of Nimbus meteorological satellites first launched Aug. 1964.
	Cameo	To study solar energy and plasma flows and electric fields in Arctic regions through release of barium and lithium in and above the earth's ionosphere.	Delta WTR	S	S	Project Cameo (Chemically Active Materials Ejected in Orbit) launched as a piggyback payload with *Nimbus 7.*
Nov. 13	*HEAO 2*	A high-energy astronomical observatory intended to detect x-rays from objects two-thirds of the way toward the edge of the universe.	Atlas-Centaur ETR	S	S	Second in a series of three NASA high-energy astronomical observatories, made more detailed observations of x-ray sources identified by *HEAO 1.*
Nov. 19	*NATO III C*	To place satellite into transfer orbit that will allow ultimate placement into a stationary synchronous orbit for communications.	Delta ETR	S	S	Third and last of a series of NATO communications satellites launched by NASA, intended to provide backup services for earlier ones.
Dec. 16	*Anik 4* *(Telesat D)*	Intended to provide transmission of television, voice, and other data throughout Canada.	Delta ETR	S	S	Second-generation satellite, fourth in a series orbited for Canada's domestic communications-satellite system.

Appendix C

MANNED SPACEFLIGHTS, 1978

Manned flight activity worldwide in 1978 consisted of five launches, all in the USSR Soyuz series. All crews docked successfully with *Salyut 6*. These missions carried the first Czech, Polish, and GDR cosmonauts. The crew of *Soyuz 29,* who returned in *Soyuz 31*, set a duration record of 3350hr. 48min.

At the end of 1978, the U.S. had made 31 manned space flights (2 suborbital, 20 in earth orbit, 3 in lunar orbit, and 6 lunar landings) with a total of 43 different crewmen. The USSR had made 41 manned flights, all in earth orbit, with 54 cosmonauts.

MANNED SPACEFLIGHTS, 1978

Date (Ship)		Designation; Crew	Weight (km)	Duration	Remarks
Launched	Recovered				
Jan. 10	Mar. 16	*Soyuz 27* (Pamir) Vladimir Dzhanibekov Oleg Makarov	6570 (est.)	(ship) 1555 h 53min (crew) c. 140h	Carried a second crew to enter Jan. 11 the *Salyut 6* orbiting laboratory, already occupied by the crew of *Soyuz 26* docked at the aft port. After 5 days on *Salyut 6*, the *Soyuz 27* crew returned to earth aboard *Soyuz 26*, releasing the aft docking unit for use by cargo ship *Progress 1* that arrived Jan. 22, left Feb. 6. (*Soyuz 26* undocked from *Salyut 6* Jan. 16, landed with the *Soyuz 27* crew the same day.)
Mar. 2	Mar. 10	*Soyuz 28* (Zenit) Aleksey Gubarov Vladimir Remek	6570 (est.)	(ship and crew) 190h 17min	Carried the third crew to board the *Salyut 6* orbiting laboratory. The crew included cosmonaut researcher Captain Vladimir Remek of the Czech Army, first non-Soviet or non-American to fly into space. *Soyuz 28* docked with *Salyut 6* aft port Mar. 3; crew transferred on that same day; returned in *Soyuz 28* Mar. 10. (Record-breaking *Soyuz 26* crew returned in *Soyuz 27* Mar. 16.)
June 15	Sept. 3	*Soyuz 29* (Foton) Vladimir Kovalenok Aleksandr Ivanchenkov	6570 (est.)	(ship) 1911h 23min (crew) 3350h 45min	Manned spacecraft continuing the occupation of *Salyut 6* begun earlier in the year. *Soyuz 29* crew docked with *Salyut 6* forward port June 16; hosted 2 other crews during 140-day stay; vehicle returned with *Soyuz 31* crew Sept. 3.
June 27	July 5	*Soyuz 30* (Kavkaz) Pyotr Klimuk Miroslaw Hermaszewski	6570 (est.)	(ship and crew) 190h 4min	Carried the second international crew, with flight engineer Major Miroslaw Hermaszewski of the Polish Air Force, to *Salyut 6*, already occupied by *Soyuz 29* crew. *Soyuz 30* docked with aft port of *Salyut 6* June 28, undocked and landed July 5; port used by *Progress 2* cargo vessel July 9-Aug. 2, *Progress 3* Aug. 10-21.
Aug. 26	Nov. 2	*Soyuz 31* (Yastreb) Valery Bykovsky Sigmund Jähn	6600 (est.)	(ship) 1628h 14min (crew) 188h 49min	Carried the third international crew, including cosmonaut researcher Sigmund Jähn of the German Democratic Republic, to *Salyut 6*. *Soyuz 31* docked Aug. 27 at aft port of *Salyut 6*; crew returned in *Soyuz 29* Sept. 3 after a flight of 7.9 days. (On Sept. 7, *Soyuz 29* crew entered *Soyuz 31*, undocked from *Salyut 6*, and (after the station had been rotated) redocked with the forward docking unit, leaving aft port free for *Progress* cargo-vessel use. *Progress 4* arrived Oct. 6 to refuel station and boost its trajectory; undocked Oct. 24, reentered Oct. 26. *Soyuz 29* crew returned in *Soyuz 31* Nov. 2.)

Appendix D

NASA SOUNDING ROCKET LAUNCHES, 1978

The accompanying table lists the 60 sounding rockets of the Arcas class and above launched by NASA in 1978. Launch sites were in Antarctica, Norway, Canada, and Sweden, as well as the United States. The rockets carried payloads for the Naval Research Laboratory, SAO, American Science & Engineering, Aerospace Corp., NOAA, GSFC, MSFC, WFC, Norway, and 17 universities. Types of onboard experiments included 28 in plasma physics, 4 in solar physics, 9 in aeronomy, 7 in astrophysics, 4 in astronomy, 4 in meteorology, 2 in stratosphere research, 1 in space processing, and 1 vehicle systems test.

Information for the table came from Goddard Space Flight Center's Quick-Look Sounding Rocket data sheets, issued after launches, with additional information from some of the experimenters concerned. Launch dates are in local time.

NASA SOUNDING ROCKET LAUNCHES, 1978

Launch Date	Rocket, NASA Designation, Launch Site	Apogee (km)	Remarks
Jan. 1	Super Arcas 15.161UE Siple Station, Antarctica	?	Univ. of Houston plasma-physics experiment.
	Super Arcas 15.162UE Siple Station, Antarctica	?	Univ. of Houston plasma-physics experiment.
	Nike Apache 14.533UE Wallops Flight Center, Va.	196.5	Univ. of Ill. plasma-physics experiment.
Jan. 4	Super Arcas 15.160UE Siple Station, Antarctica	250 ft.	Univ. of Houston plasma-physics experiment; failed.
Jan. 9	Astrobee F 25.029GA White Sands Missile Range, N.M.	163	GSFC aeronomy experiment.
Jan. 10	Astrobee F 25.012UH White Sands Missile Range, N.M.	196.3	SAO high-energy astrophysics experiment; partial failure.
Jan. 12	Super Arcas 15.163UE Siple Station, Antarctica	?	Univ. of Houston plasma-physics experiment.
Jan. 30	Nike Tomahawk 18.211UE Andoya, Norway	220	Univ. of Md. plasma-physics experiment.
Jan. 31	Nike BBVC 27.029CS White Sands Missile Range, N.M.	273	American Science and Engineering solar-physics experiment.

Feb. 2	Terrier Malemute 29.008UE Poker Flat Range, Al.	616	Univ. of Wisc. plasma-physics (auroral) experiment.
Feb. 4	Aerobee 200A 26.063UH White Sands Missile Range, N.M.	28.5 (sm)	Univ. of Wisc. high-energy astrophysics (cosmic x-ray) experiment; failed.
Feb. 10	Black Brant VB 21.056UG White Sands Missile Range, N.M.	147.9 (sm)	Johns Hopkins Univ. galactic-astronomy experiment.
Feb. 13	Black Brant VC 21.042DS White Sands Missile Range, N.M.	210	NRL solar-physics experiment.
Feb. 27	Nike Tomahawk 18.1017UE Poker Flat Range, Al.	?	Univ. of Al. plasma-physics (barium ion injection) experiment.
Feb. 28	Aerobee 170 13.136DA White Sands Missile Range, N.M.	222.7	NRL aeronomy experiment.
Feb. 28	Nike Tomahawk 18.1015UE Poker Flat Range, Al.	?	Cornell Univ. plasma-physics experiment.
Mar. 2	Nike Tomahawk 18.1016UE Poker Flat Range, Al.	?	Cornell Univ. plasma-physics experiment.
Mar. 8	Astrobee F 25.023UH White Sands Missile Range, N.M.	189.5	MIT high-energy astrophysics (x-ray mapping) experiment.
Mar. 9	Terrier Malemute 29.007UE Poker Flat Range, Al.	336	Rice Univ. plasma-physics (magnetospheric) experiment.
Mar. 10	Nike Tomahawk 18.1018UE Poker Flat Range, Al.	?	Univ. of Al. plasma-physics experiment.

Launch Date	Rocket, NASA Designation, Launch Site	Apogee (km)	Remarks
Mar. 12	Taurus Orion 33.001UA Fort Churchill, Canada	204.4	Univ. of Pitt. plasma-physics (aeronomy) experiment.
Mar. 13	Astrobee F 25.031UE CRR	198	Univ. of Mich. plasma-physics (energetic-particle flux and UV radiation) experiment.
Mar. 21	Super Arcas 15.165GA Poker Flat Range, Al.	62	GSFC aeronomy experiment.
Mar. 27	Super Arcas 15.167GA Poker Flat Range, Al.	67	GSFC aeronomy experiment; partial failure.
	Super Arcas 15.169GA Poker Flat Range, Al.	67	GSFC aeronomy experiment.
	Nike Tomahawk 18.215GM Poker Flat Range, Al.	219	GSFC meteorology (auroral energetics) experiment.
	Super Arcas 15.170UE Poker Flat Range, Al.	75	Penn. State Univ. plasma-physics experiment.
Mar. 29	Super Arcas 15.164GA Poker Flat Range, Al.	63	GSFC aeronomy experiment.
	Super Arcas 15.166GA Poker Flat Range, AL.	62	GSFC aeronomy experiment.

Mar. 29	Super Arcas 15.168GA Poker Flat Range, Al.	60	GSFC aeronomy experiment.
	Nike Tomahawk 18.214GM Poker Flat Range, Al.	?	GSFC meteorology (auroral energetics) experiment.
Mar. 30	Super Arcas 15.171UE Poker Flat Range, Al.	57.8	Penn. State Univ. plasma-physics (electric field measurements) experiment.
	Taurus Orion 33.002GA CRR	179	GSFC plasma-physics (aeronomy) experiment.
Apr. 9	Nike BBVB 27.010AE CRR	247	NOAA plasma-physics (electric fields) experiment.
Apr. 11	Nike BBVC 27.026UH White Sands Missile Range, N.M.	303	Univ. of Calif., Berkeley, high-energy astrophysics (spectroscopic) experiment.
Apr. 13	Nike Orion 31.006UE Esrange, Sweden	154	Johns Hopkins Univ. plasma-physics experiment.
May 6	Aerobee 170A 13.137UH White Sands Missile Range, N.M.	200.2	Univ. of Wisc. high-energy astrophysics (cosmic x-ray background) experiment.
May 15	Astrobee F 25.026DG White Sands Missile Range, N.M.	211	NRL galactic-astronomy (x-ray UV) experiment.
June 11	Nike Apache 14.539UE Wallops Flight Center, Va.	219 709 (m)	Cornell Univ. plasma-physics experiment.
June 15	Nike Tomahawk 18.1023UE White Sands Missile Range, N.M.	265.3	Univ. of Tex., Dallas, plasma-physics experiment.

Launch Date	Rocket, NASA Designation, Launch Site	Apogee (km)	Remarks
June 20	Nike Apache 14.543UE Wallops Flight Center, Va.	184	Univ. of Ill. plasma-physics experiment.
June 26	Nike Tomahawk 18.1019CE Wallops Flight Center, Va.	314.7	Aerospace Corp. plasma-physics experiment.
July 20	Astrobee F 25.037UH White Sands Missile Range, N.M.	190	SAO high-energy astrophysics experiment.
Aug. 14	Nike BBVC 27.034DS White Sands Missile Range, N.M.	220	NRL solar-physics (high-resolution telescope spectrograph) experiment; failed.
Aug. 15	Super Arcas 15.158UU Wallops Flight Center, Va.	61.5	Univ. of Mich. stratosphere research.
Aug. 29	Super Arcas 15.157UU Wallops Flight Center, Va.	63	Univ. of Mich. stratosphere (nitric oxide) research.
Sept. 11	Black Brant V 21.046NP White Sands Missile Range, N.M.	165	MSFC space-processing experiment.
Sept. 20	Astrobee F 25.028UL White Sands Missile Range, N.M.	224	Univ. of Colo. lunar and Venusian astronomy (UV) research.
Sept. 26	Astrobee F 25.042GG White Sands Missile Range, N.M.	231	GSFC galactic-astronomy (UV) research.

Sept. 27	Nike Apache 14.542UE Wallops Flight Center, Va.	182.6	Univ. of Ill. plasma-physics experiment.
Oct. 31	Taurus Tomahawk 12.1005WT Wallops Flight Center, Va.	554.7	WFC vehicle-system test.
Nov. 3	Aerobee 170A 13.135UE White Sands Missile Range, N.M.	151	Univ. of Mich. plasma-physics (atomic oxygen in night glow) experiment.
Nov. 16	Aerobee 170A 13.138GS White Sands Missile Range, N.M.	?	GSFC solar-physics experiment.
Nov. 27	Nike Tomahawk 18.207IE Andoya, Norway	?	GSFC/NDRE, Norway, plasma-physics (auroral) experiment.
	Nike Tomahawk 18.216IE Andoya, Norway	?	GSFC/NDRE, Norway, plasma-physics (auroral) experiment.
Dec. 1	Astrobee F 25.038UL White Sands Missile Range, N.M.	238	Johns Hopkins Univ. lunar and planetary (Jupiter) astronomy research.
Dec. 11	Nike Tomahawk 18.1024UA White Sands Missile Range, N.M.	228	Univ. of Minn. plasma-physics (aeronomy) experiment.
	Astrobee F 25.001UH White Sands Missile Range, N.M.	163.5	Calif. Inst. of Tech. high-energy astrophysics (stellar x-ray sources) research.
Dec. 15	Super Arcas 15.149GM White Sands Missile Range, N.M.	70	GSFC meteorology (ozone) research.
	Super Arcas 15.197GM Wallops Flight Center, Va.	—	GSFC meteorology research.

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Appendix E

ABBREVIATIONS OF REFERENCES

Listed here are the abbreviations used for citing sources in the text. Not all the sources are listed, only those that are abbreviated.

AAAS Bull	American Association for the Advancement of Science's *AAAS Bulletin*
A&A	American Institute of Aeronautics and Astronautics' magazine, *Astronautics & Aeronautics*
A&A 1977	NASA's *Astronautics and Aeronautics, 1977: A Chronology*
ABC	American Broadcasting Company
AEC Release	Atomic Energy Commission news release
Aero Daily	*Aerospace Daily* newsletter
Aero Med	*Aerospace Medicine* magazine
AF Mag	Air Force Association's *Air Force Magazine*
AFHF Newsletter	*Air Force Historical Foundation Newsletter*
AFJ	*Armed Forces Journal* magazine
AFSC *Newsreview*	Air Force Systems Command's *Newsreview*
AFSC Release	Air Force Systems Command news release
AIA Release	Aerospace Industries Association of America news release
AIAA *Facts*	American Institute of Aeronautics and Astronautics' *Facts*
AIAA Release	American Institute of Aeronautics and Astronautics news release
AIP *Newsletter*	American Institute of Physics *Newsletter*
AP	Associated Press news service
ARC *Astrogram*	NASA Ames Research Center's *Astrogram*
Astro Journ	American Astronomical Society's *Astrophysical Journal*
Atlanta JC	*Atlanta Journal Constitution* newspaper
AvWk	*Aviation Week & Space Technology* magazine
B News	*Birmingham News* newspaper
B Sun	Baltimore *Sun* newspaper
Bull Atom Sci	Education Foundation for Nuclear Science's *Bulletin of the Atomic Scientists*
Bus Wk	*Business Week* magazine
C Daily News	*Chicago Daily News* newspaper
C Trib	*Chicago Tribune* newspaper
Can Press	Canadian Press news service
CBS	Columbia Broadcasting System

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C&E News	*Chemical & Engineering News* magazine
Cl *PD*	Cleveland *Plain Dealer* newspaper
Cl Press	*Cleveland Press* newspaper
Columbia J Rev	*Columbia Journalism Review* magazine
ComSatCorp Release	Communications Satellite Corporation news release
CQ	*Congressional Quarterly*
CR	*Congressional Record*
CSM	*Christian Science Monitor* newspaper
CTNS	Chicago Tribune News Service
D News	*Detroit News* newspaper
D Post	*Denver Post* newspaper
DASA Release	Defense Atomic Support Agency news release
DFRC	See FRC.
DJ	Dow Jones news service
DOC PIO	Department of Commerce Public Information Office
DOD Release	Department of Defense news release
DOT Release	Department of Transportation news release
EOP Release	Executive Office of the President news release
ESA Release	European Space Agency news release, use dated (not numbered)
FAA Release	Federal Aviation Administration news release
FBIS – Sov	Foreign Broadcast Information Service, Soviet number
FonF	*Facts on File*
FRC Release	Flight Research Center news release, after 8 Jan. 1976, became Dryden Flight Research Center (DFRC) news release
FRC *X-Press*	NASA Flight Research Center's *X-Press*
GE Forum	*General Electric Forum* magazine
Goddard News	NASA Goddard Space Flight Center's *Goddard News*
GSFC Release	NASA Goddard Space Flight Center news release
GSFC *SSR*	NASA Goddard Space Flight Center's *Satellite Situation Report*
GT&E Release	General Telephone & Electronics news release
H Chron	*Houston Chronicle* newspaper
H Post	*Houston Post* newspaper
INTELSAT Release	Intl. Telecommunications Satellite Org. news release
JA	*Journal of Aircraft* magazine
JPL *Lab-Oratory*	Jet Propulsion Laboratory's *Lab-Oratory*

JPL Release	Jet Propulsion Laboratory news release
JPRS	Department of Commerce Joint Publications Research Service
JSC Release	NASA Lyndon B. Johnson Space Center (Manned Spacecraft Center until 17 Feb. 1973) news release
JSC *Roundup*	NASA Lyndon B. Johnson Space Center's *Space News Roundup*
JSR	American Institute of Aeronautics and Astronautics' *Journal of Spacecraft and Rockets* magazine
KC Star	*Kansas City Star* newspaper
KC Times	*Kansas City Times* newspaper
KSC Release	NASA John F. Kennedy Space Center news release
LA *Her-Exam*	Los Angeles *Herald-Examiner* newspaper
LA Times	*Los Angeles Times* newspaper
Langley Researcher	NASA Langley Research Center's *Langley Researcher*
LaRC Release	NASA Langley Research Center news release
LATNS	Los Angeles Times News Service
LeRC Release	NASA Lewis Research Center news release
Lewis News	NASA Lewis Research Center's *Lewis News*
M HER	*Miami Herald* newspaper
M News	*Miami News* newspaper
M Trib	*Minneapolis Tribune* newspaper
Marshall Star	NASA George C. Marshall Space Flight Center's *Marshall Star*
MJ	*Milwaukee Journal* newspaper
MSFC Release	NASA George C. Marshall Space Flight Center news release
N Hav Reg	*New Haven Register* newspaper
N News	*Newark News* newspaper
N Va Sun	*Northern Virginia Sun* newspaper
NAA *News*	National Aeronautic Association *News*
NAA Record Book	National Aeronautic Association's *World and U.S.A. National World Aviation—Space Records*
NAC Release	National Aviation Club news release
NAE Release	National Academy of Engineering news release
NANA	North American Newspaper Alliance
NAS Release	National Academy of Sciences news release
NAS—NRC Release	National Academy of Sciences—National Research Council news release

NAS–NRC–NAE *News Rpt*	National Academy of Sciences–National Research Council–National Academy of Engineering *News Report*
NASA Actv	*NASA Activities*
NASA anno	NASA announcement
NASA GMR	NASA Headquarters "General Management Review Report"
NASA HHR–39	NASA Historical Report No. 39
NASA Hist Off	NASA History Office
NASA Hq *WB*	NASA Headquarters *Weekly Bulletin*
NASA Int Aff	NASA Office of International Affairs
NASA *LAR*, XIII/8	NASA *Legislative Activities Report*, Vol. XIII, No. 8
NASA Leg Off	NASA Office of Legislative Affairs
NASA MOR	NASA Headquarters Mission Operations Report, preliminary prelaunch and postlaunch report series (information may be revised and refined before publication)
NASA prog off	NASA program office (for the program reported)
NASA proj off	NASA project office (for the project reported)
NASA Release	NASA Headquarters news release
NASA Rpt SRL	NASA report of sounding rocket launching
NASA SP-4019	NASA Special Publication No. 4019
Natl Obs	*National Observer* magazine
Nature	*Nature Physical Science* magazine
NBC	National Broadcasting Company
NGS Release	National Geographic Society news release
NMI	NASA Management Instruction
NN	NASA Notice
NOAA Release	National Oceanic and Atmospheric Administration news release
NRL Release	Naval Research Laboratory news release
NSC Release	National Space Club news release
NSC *News*	National Space Club *News*
NSC *Letter*	National Space Club *Letter*
NSF *Highlights*	National Science Foundation's *Science Resources Studies Highlights*
NSF Release	National Science Foundation news release
NSTL Release	NASA National Space Technology Laboratories news release
NY News	*New York Daily News* newspaper
NYT	*New York Times* newspaper

NYTNS	New York Times News Service
O Sen Star	*Orlando Sentinel Star* newspaper
Oakland Trib	*Oakland Tribune* newspaper
Omaha W-H	*Omaha World-Herald* newspaper
ONR *Rev*	Navy's Office of Naval Research *Reviews*
P *Bull*	Philadelphia *Evening* and *Sunday Bulletin* newspaper
P Inq	*Philadelphia Inquirer* newspaper
PAO	Public Affairs Office
PD	National Archives and Records Service's *Weekly Compilation of Presidential Documents*
PIO	Public Information Office
PMR *Missile*	USN Pacific Missile Range's *Missile*
PMR Release	USN Pacific Missile Range news release
Pres Rpt 74	*Aeronautics and Space Report of the President: 1974 Activities*
SAO Release	Smithsonian Astrophysical Observatory news release
D/SBD	*Defense/Space Business Daily* newspaper
Sci Amer	*Scientific American* magazine
Sci & Govt Rpt	*Science & Government Report,* independent bulletin of science policy
SciServ	Science Service News service
SD	*Space Digest* magazine
SD Union	*San Diego Union* newspaper
SET Manpower Comments	Scientific Manpower Commission's *Scientific, Engineering, Technical Manpower Comments*
SF	British Interplanetary Society's *Spaceflight* magazine
SF Chron	*San Francisco Chronicle* newspaper
SF Exam	*San Franciso Examiner* newspaper
Sov Aero	*Soviet Aerospace* newsletter
Sov Rpt	Center for Foreign Technology's *Soviet Report* (translations)
SP	*Space Propulsion* newsletter
Spaceport News	NASA John F. Kennedy Space Center's *Spaceport News*
Spacewarn	IUWDS World Data Center A for Rockets and Satellites' *Spacewarn Bulletin*
SR list	NASA compendium of sounding rocket launches
SSN	*Soviet Sciences in the News,* publication of Electro-Optical Systems, Inc.

St Louis G-D	*St. Louis Globe-Democrat* newspaper
St Louis P-D	*St. Louis Post-Dispatch* newspaper
T-Picayune	New Orleans *Times-Picayune* newspaper
Tech Rev	Massachusetts Institute of Technology's *Technology Review*
Today	*Today* newspaper
testimony	Congressional testimony, prepared statement
text	Prepared report or speech text
transcript	Official transcript of news conference or congressional hearing
UN Reg	United Nations Public Registry of Space Flight
UPI	United Press International news service
USGS Release	U.S. Geological Survey news release
USPS Release	U.S. Postal Service news release
W Post	*Washington Post* newspaper
W Star-News	*Washington Star-News* newspaper
WFC Release	NASA Wallops Flight Center news release
WH Release	White House news release
WJT	*World Journal Tribune* newspaper
WSJ	*Wall Street Journal* newspaper

Index

Aborted flights, 106
Abourezk, James, 196
Abruzzo, Ben, 199
Acton, Loren, 94, 184
Acurex, Inc., 249
Adams, Brock, 32
AEG Telefunken, 171
Aeritalia, 33
Aero Club of Great Britain, 101
Aerospace Corp., 50
Aerospace Industries Association, 32, 100, 314
Africa, 3, 5
AFSatCom, 11, 26
Agency for International Development, 38, 58, 175
Agriculture, 69, 74, 97, 145, 187, 188, 272
Agriculture, Department of, 1
Air Force, 8, 11, 17, 22, 25, 26, 35, 82, 100, 113, 118, 153, 157, 203
  aborted mission, 64
  Aeronautical Systems Division, 312
  Avionics Laboratory, 286
  contractors, 28, 45, 46, 90
  contracts, 179
  Flight Dynamics Laboratory, 63
  Geophysics Laboratory, 311
  Project Blue Book, 74
  Space and Missile Systems Organization, 90, 135, 261, 286, 313
  Space and Missile Test Command, 144
Air Force Geophysical Laboratory, 235
Air-launched cruise missile, 5
Aircraft
  civilian, 8, 32, 65, 70, 72, 154
  design, 8, 43, 96, 209, 230
  experimental, 101, 139, 157, 174, 225, 255
  Gossamer Condor, 45
  military, 9
  research, 64, 87, 89, 92, 301
  supersonic, 43, 296, 311
  testing, 56
  transport, 5, 35, 41, 47, 200, 255, 301
Aircraft Energy Efficiency Program, 41
Airlines, U.S., 206
Airports, 39, 42, 59, 72, 121, 126, 173
  Gosselies, 5
  Kjevik, 5
  Nairobi, 5
  Yoff, 5

Albers, James, 296
Aleutian, Islands, 71
Alexander, Joseph, 192
Alfa 2 (launch vehicle), 33
Allen, Joseph, 178
Allenby, Richard, 21
Aller, Robert, 307
Allnutt, Robert, 135, 231
Alloys, 36
American Association for the Advancement of Science, 35, 91
American Astronautical Society, 91
American Astronomical Society, 268
American Indians, 81
American Institute of Aeronautics and Astronautics, 10, 35, 68, 91, 99, 108, 142
American Society of Engineering Education, 200
American Telephone & Telegraph Co., 113, 137
American Water Resources Association, 236
Ames Industrial Corp., 43
Ames Research Center, 17, 80
  contract, 111
  missions, 270, 282, 293
  people, 167, 263
  programs, 39, 43, 64, 86, 190, 233
Amsat, 206
Amsat Oscar, 53
Anderson, Arthur, 74
Anderson, Maxie, 199
Andrews, Bill, 68
Anik A1, 289
ANS (satellite, Netherlands), 163
Antarctic, 43
Antennas, 10, 108
  ground-based, 26, 71, 106, 155, 202, 246, 305
  space-based, 3, 109, 149, 158, 160
Anti-gravity forces protection, 312
Apollo 8, 279
Apollo 11, 79
Apollo 13, 98
Apollo 15, 179
Apollo 16, 168
Apollo-Soyuz, 10, 42, 79, 160
APPLE (India), 207
Apple (satellite), 304
Applications Explorer Missions, 95
Applications Systems Verification and Transfer, 54
Applications Technology Satellite 6, 192
Aquarius (command module), 98
Arco Solar, Inc., 240
Argentina, 12, 273
Ariane, 7, 20, 59, 93, 140, 153, 206, 216, 223, 280, 294, 297, 304
Ariel-5, 60
Armstrong, Neil, 77, 224
Army, 8, 17, 64, 86, 113, 235
  Ballistic Missile Agency, 16

ARO, Inc., 205
Association for the Space Science Exposition, 79
Asteroids, 211
Astrobee F (rocket), 311
Astrometry, 20
Astronauts, 7, 27, 35, 39, 42, 56, 61, 70, 74, 94, 98, 106, 129, 157, 172, 191, 209, 224, 231, 238
  pilots, 8
  scientists, 8
Astronomy, 15, 35, 70, 78, 95, 132, 145, 165, 167, 168, 184, 186, 190, 193, 214, 239, 243, 275
Atlas (rocket), 2, 5, 89, 94, 121, 123, 144, 210
Atlas-Agena, 82
Atlas-Centaur, 2, 3, 5, 25, 86, 94, 96, 136, 143, 168, 173, 194, 262, 268, 272, 297
ATMOSAT project, 50
Atmosphere Explorer C, 192
Atmospheric cloud physics laboratory, 95
Atmospheric variability experiments, 109
ATS-6 (satellite), 79
Australia, 5, 6, 92, 145, 272
Automatic pilot-advisory system, 97
Aviation Regulatory Reform Act, 311
Aviation Week, 2
Aviation/Space Writers Association, 32
AWACS (aircraft), 204
Awards, 26, 35, 45, 49, 67, 82, 99, 101, 103, 107, 136, 142, 152, 178, 185, 200, 216, 224, 228, 230, 235, 238, 243, 247, 252, 263, 299
B-1 bomber, 9, 75
BAe Dynamics Group (UK), 132
Bahcall, J. N., 109
Bainbridge, William, 154
balloons, 37, 109, 199
Barber, Paul, 199
Bartoe, John-David, 94, 184
Bell Helicopter Textron, 64
Bell-Northern Research Ltd., 39
Beloit College, 109
Bendix Corp., 202, 296
Benham, Harold, 154
Berezhnoy, Igor, 42
Berger, Harold, 292
Big Bird (satellite), 266
Bioengineering, 52
Biology, 39, 43, 49, 70, 138
Blackstock, Thomas, 103
Blamont, Jacques, 50
Blocker, Truman, 114
Blue Ridge Electrical Membership Corp., 171
Bluford, Guion, 8
Boeing Aerospace Co., 5, 35, 89, 90, 96, 156, 249, 255, 303, 313
Boeing Engineering and Construction Co., 249
Bond, Langhorne, 5, 20
Borman, Frank, 224
Botany, 43

Bowen, Fred, 107
Boyd, John 252
Boynton, Judd, 268
Brand, Vance, 61
Brandenstein, Daniel, 8
Brazil, 12, 119, 273
Bristow, Frank, 87
British Aerospace Dynamics Corp., 111, 143, 285
British Civil Aviation Authority, 108
British Interplanetary Society, 91, 131
British Science Research Council, 186
Brown, Harold, 1, 130
Brown, Richard, 110
Brzezinski, Zbigniew, 19
BSE satellite, 97
Buchli, James, 8
Buckner, Horst, 32
Bulgaria, 49, 263
Bunker Ramo Corp., 179
Bykovsky, Valery, 200
C-5 aircraft, 5
C-130 aircraft, 5
C-141 aircraft, 5
Cable & Wireless, Ltd. (UK), 68
Calder, Peter, 171
Caldwell, J. J., 109
California Institute of Technology, 152
Calio, Anthony, 214
Calspan Corp., 151
CalTech, 27, 122, 244
Canada, 4, 5, 12, 18, 38, 39, 94, 121, 202, 223, 272, 275, 294
Canaveral Council of Technical Societies, 195
Cape Canaveral, 5, 22, 62, 64, 82, 88, 93, 100, 268
Carlos, H.M. Juan, 109
Carr, Gerald, 224
Carter, Jimmy, 1, 8, 9, 28, 31, 44, 45, 46, 74, 75, 77, 92, 104, 113, 115, 122, 130, 142, 178, 224, 235, 239, 241, 245, 249, 260, 265, 274, 275
Caruso, Andrea, 15
Cassidy, William, 37, 38, 144
Ceallaigh, C. O., 32
Central Intelligence Agency, 1
Centre National d'Etudes Spatiales (France), 20, 50, 140, 210
Chaffee, Roger, 231
Chapman, Kenneth, 4, 116
Charles Stark Draper Laboratory, Inc., 189
Chase Econometrics, 63
Chemical clouds, 255
Cheston, T. Stephen, 79
Chimex Systems, Inc., 181
China, 33, 170
China Navigation Society, 27
Chirivella, Jose, 152
Chitre, NandKishore, 15
Christopher, Warren, 280

Civil Aeronautics Board, 40, 113
Civil Aviation Authority (UK), 20
Civil Service Commission, 44
Clanton, Uel, 187
Clapper, Peter, 46
Clouds, 95, 162, 255
Coast Guard, 121, 176, 293
Coats, Michael, 8
Cohen, Aaron, 191
Comets, 88
Communications
  global systems, 47, 57, 78, 81, 83, 108, 153, 246, 304
  global systems antenna, 10
  lasers, 286
  problems, 203
  submarines, 203
  systems, 14, 25, 39
Communications Technology Satellite, 81
Computer Sciences Corp., 155, 181, 211
Computer Systems, 2, 6, 43, 49, 51, 81, 85, 141, 167, 172, 254
  massive parallelism, 72
  spacecraft, 87, 167
Comsat General, 147
ComSatCorp, 2, 3, 5, 7, 15, 47, 58, 94, 108, 113, 136, 143, 171, 202, 280, 314
Comsats, 64, 80, 81, 83, 93, 108, 121, 136, 159, 164, 166, 261, 275, 277, 284, 291, 304
COMSTAR, 47, 136, 314
Concorde, 8, 43, 59, 171, 311
Condor, Gossamer, 70
Conferences. See meetings, 55
Congress, U.S.
  conference committees, 9
  House of Representatives, 38, 52, 92, 93, 103, 112, 132, 155, 289
  Senate, 75, 81, 92, 103, 112, 155, 289
Conrad, Jr., Charles, 224
Construction in space, 18, 84
Control systems, 6, 15, 43, 202, 263, 272, 277, 312
Copernicus (orbiter), 12, 16, 165
Cornell University, 268
Corning Glass Works, 6
Cosmic rays, 32, 95
Cosmology, 243
Cosmonauts, 7, 13, 31, 36, 49, 56, 85, 150, 176, 193, 200, 224, 254, 261
Cosmos 936, 14
Cosmos 954, 18, 38, 275
Cosmos 1031, 227
Cosmos 1047, 275
Cosmos program, 80, 123, 151, 187
Cost reductions, 1, 9, 35, 30, 42, 84, 105, 178, 201
Counts, Parker, 254
Covert, Eugene E., 75
Covey, Richard, 8
Cox, Roy, 108
Cranston, Alan, 9
Creighton, John, 8

Crippen, Robert, 61
Crow, Duward, 136
Cruise missiles, 100
Cts (satellite), 39, 121, 202
Cuba, 49, 69
Curien, Hubert, 117
Czechoslovakia, 49, 69, 125, 263, 277
Dana, Bill, 249
Data
  analysis, 2, 4, 6, 28, 35, 52, 88, 142, 166, 174, 271, 300
  collection, 4, 7, 34, 40, 42, 60, 77, 95, 96, 109, 143, 192, 198, 210
  management, 298
  processing, 179
  relay, 181, 196
  storage, 10, 179
  systems, 244
  transmission, 21, 57, 84, 145, 171, 223, 247
  users, 282
Data-relay satellite, 155
Day, Roy, 75
de Havilland Aircraft, 174
de Laboulaye, Francois, 280
DeBakey, Michael, 148
Deep Space Network, 67, 219, 274
Defense Advanced Research Projects Agency, 185
Defense Meteorological Satellite Program, 204
Delta (rocket), 5, 15, 16, 40, 88, 93, 94, 97, 110, 116, 146, 221, 254, 261, 275, 277
Department of Agriculture, 31, 57, 82, 188, 273
Department of Commerce, 4, 31
  National Telecommunications and Information Administration, 274
Department of Defense, 1, 11, 18, 21, 25, 26, 29, 31, 75, 77, 89, 115, 116, 122, 126, 155, 186, 203
  Advanced Research Project Agency, 169
Department of Energy, 13, 31, 45, 52, 60, 68, 87, 112, 167, 171, 196, 233, 249
Department of Interior, 1, 31, 38, 57, 82, 236
Department of State, 29
Department of Transportation, 40, 46, 99, 173, 226, 311
Design
  aircraft, 8
  engineering, 2, 19, 247, 291
  instrumentation, 50
  spacecraft, 2, 292, 302
Detroit Diesel Allison Division (GM Corp.), 60
Development Sciences, Inc., 300
Dhawan, S., 164
Dinneen, Gerald, 203
Divita, David, 88
Dixon, Robert J., 82
DNA and RNA, 138
Domingo, D.V., 32
Double Eagle II, 199
Dryden Flight Research Center, 29, 43, 56, 83, 225
Dscs 2 (satellite), 78
DuPont Corp., 50

Dupree, Andrea, 186
Dzhanibekov, Vladimir, 7
E-Systems, Inc., 159
Earhart, Amelia, 83, 107
Eastern Test Range, 86, 169, 286
Economics
  aerospace industry, 4, 314
  aviation industry, 72, 206
  B-1 bomber, 9
  data storage, 10
  European space program, 278
  satellite launch, 245
  see also expenditures, 3
Ecuador, 21
Edelson, Edward, 137
Education, 310
Edwards Air Force Base, 28
Egypt, 164
El-Baz, Farouk, 164
Electric Space Division, 249
Electricity, generated from space, 80
Electronic message systems, 279
Elliott, David, 87
Elliot, Jim, 268
Emme, Eugene, 91
EMR Telemetry, 227
Encke comet, 229
Energy
  conservation, 31, 35, 43, 68, 71, 103, 131, 137, 201, 215, 259, 291, 298
  costs, 220
  efficiency, 41
Energy Materials Corp., 240
England, 4
Engle, Joe, 61
ENTEL, 202
Enterprise (orbiter), 6, 11, 29, 121
Environmental Protection Agency, 31, 58, 145
Environmental Research & Technology, Inc., 314
Environmental Research Laboratory, 17
Eppley Laboratory, Inc., 13
ERNO (W. Germany), 27, 251
Erythrocytes, 298
Escuela Politecnia National (Ecuador), 21
European Broadcast Union, 110
European Space Agency, 5, 7, 11, 15, 16, 20, 27, 33, 34, 57, 59, 83, 84, 88, 94, 109, 111, 129, 140, 143, 150, 153, 159, 165, 177, 183, 186, 198, 206, 212, 218, 254, 265, 278
  expenditures, 93
  Ots 2, 110
European Space Operations Centre, 85, 109, 143, 177, 282
Eutelsat, 160, 198
Evans, John, 67
Exos B, 212
Exosat, 93, 216
Expenditures

  comsats, 291
  climate research, 31
  European Space Agency, 111
  Intelsat program, 3, 119
  meteosat, 213
  MX-missile, 1
  National Aeronautics and Space Administration, 152
  research and development, total U.S., 103
  Space Shuttle, 44, 117, 218, 251
  See also Economics and Funding
Experiments
  atmospheric, 111
  Avefria, 111
  biological, 39
  chemical clouds, 255
  GARP, 282
  life sciences, 91
  materials processing, 30, 124, 160, 219, 233
  meteorological, 271, 283
  scientific, 29, 30, 32, 53, 70, 110, 134, 177, 184, 194, 269
Explorer, 166
Explorer 1, 16, 17, 62
Explorer 52, 147
Extraterrestrial life, 116, 144
Extravehicular activity, 50
Fabian, John, 8
Fairchild Space and Electronics Co., 30
Faise, Jr., Fred, 98
Farnham, Lee, 147
Farquhar, Robert, 276
Fastie, W. G., 110
Federal Aviation Administration, 5, 8, 20, 46, 113, 185, 202, 206, 215, 226, 298
Federal Communications Commission, 58, 113
Federal Electric Corp., 286
Federal Republic of Germany, 27, 29, 58, 85, 92, 93, 106, 148, 171, 206. 218, 251
Feoktistov, Konstantin, 85, 193, 227
Ferranti Electronics, Ltd., 246
Fichtel, Carl, 215
Finke, Wolfgang, 117
Finn, Terence, 199
Firewheel (Germany), 206
Fisher, Anna, 8
Fishman, Gerald, 215
Fletcher, James C., 26, 35
Flight safety, 18
Flippo, Ronnie, 45, 251, 289
FltSatCom, 11, 25, 52, 86, 183
Fluorocarbons, 37
Food, 278
Ford, Gerald, 260
Ford Aerospace and Communications Corp., 223, 261, 275
Forest Service, 167
Fowler, James, 204
Fox, Kenneth, 182

France, 4, 20, 39, 50, 92, 119, 140, 210
Friedmann, E. Imre, 43
Frietag, Robert F., 79
Frosch, Robert 11, 12, 38, 44, 74, 75, 81, 97, 142, 164, 191, 223, 231, 238, 247, 255, 259, 292, 311
Frutkin, Arnold, 49, 270
Fullerton, Charles, 61
Fulton, Fitzhugh, 67
Funding, 226
  government, 1, 3, 9, 13, 16, 27, 31, 44, 48, 52, 103, 196, 211, 220, 285
  research and development, 48, 103, 259, 260, 313
  See also Expenditures.
Fuqua, Don, 133, 214, 251, 289
Fury, Joe, 203
Gagarin, Yuri, 85
Galileo project, 12, 91, 148, 161
Gamma rays, 34, 95, 120, 233
  observatory, 214
Garber, Paul, 297
Gardner, Dale, 8
GARP, 282
Garrett Corp., 296
Garriott, Owen, 183
Gazenko, Oleg, 298
Geddes, William, 15
Gemini, 79
Gemini-Titan, 79
General Dynamics Corp., 5, 89, 113, 135, 137, 169, 205, 246
General Electric Co., 40, 52, 96, 114, 147, 148, 159, 171, 213, 215, 219, 225, 277, 298, 305
Geological Survey (U.S.), 187, 314
Geophysics Labs and Research, 268
George Washington University, 107
Geos (satellite), 143, 177, 194
Geos 1 and *2*, 254
Geos 2, 239
Geos 3, 284
German Democratic Republic, 49, 200
Giacconi, Riccardo, 275
Giberson, Gene, 248
Gibson, Edward, 224
Gibson, Robert, 8
Gibson, Roy, 247, 294
Gilliam, Issac, 136
Ginter, R. D. "Duff", 99
Glaser, Peter, 70
Glazer, J. Henry, 79
Glenn, Jr., John, 224
Glissada (USSR), 41
Global Associates, 303
Global Atmospheric Research Program, 116, 146, 182, 210, 299
Global communication systems, See Communications.
Global Weather Experiment, 146, 299
Goddard Space Flight Center, 16
  contractors, 30

    missions, 111
    people, 21, 192
    programs, 40, 70, 96, 110, 181, 205, 210, 213
Godfrey, Frank, 161
Goes (satellite), 109, 161, 146, 181
Goes 1, 142, 282
Goes 3, 283
Goes C, 116
Gold (presence in space), 166
Goldreich, Richard, 268
Gomez, Louis, 195
Gossamer Condor, 45, 101
Grechko, Georgy, 31, 56, 151, 224
Gregory, Frederick, 8, 39
Grey, Jerry, 132
Griffith, Cecilia, 162
Griggs, Stanley, 8
Grissom, Virgil (Gus), 225, 231
Grumman Aerospace Corp., 84, 98, 135
Gubarev, Aleksey, 49
Gurovsky, Nikolai, 14
Gursky, Herbert, 186
H-Sat, 59
Haigh, Henry, 126
Haile, Frank, 154
Haines, Bill, 303
Haise, Fred, 61
Hall, Minard, 21
Halley's comet, 88, 229
HALO experiments, 11
Hannigan, James, 254
Harr, Jr., Karl, 100
Harris Corp., 10, 204
Hart, Terry, 8
Hartsfield, Henry, 139
Harvey, John, 94
Haskins, Glenn, 87
Hauck, Frederick, 8
Hawley, Steven, 8
Hayflick, Leonard, 213
Heacox, William, 166
Head, Sara, 70
Heao, 132
Heao 1, 34, 77, 120, 239
Heao 2, 268, 272, 275, 283
Heao B, 94, 262
Hearth, Donald, 35, 107, 163, 200
Heat-capacity mapping mission, 95, 187
Helios 1, 192
Helios B, 233
Helms, Curtis, 178
Hermaszewski, Miroslaw, 150, 261
Hessberg, Rufus, 14
Heyman, Joseph, 228

HiMat (aircraft), 157
Hinners, Noel, 14, 120, 214, 229, 243, 273, 285, 290
Hoffman, Jeffrey, 8
Honeywell, Inc., 2
Horizont (satellite), 304
Horton, Vic, 68
Horz, Fred, 32
House of Representatives, U.S. See Congress, 75
Hovell, C. Ronald, 23
How-Ren, Pan, 170
Hsnmin, Jen, 284
Hughes Aircraft Co., 38, 45, 47, 96, 124, 148, 186, 312
Hughes Communications Services, Inc., 216, 280
Hughes, Thomas, 91
Hungary, 49, 263
Hussain, Farooq, 17
Hutchinson, Neil, 62
Hydrazine engine, 300
Icing, 185
Ifft, Edward, 179
ILLIAC IV (computer), 167
Imagery, 40, 47, 178
India, 7, 164, 207, 263, 273
Indian Space Research Organization, 304
Industralization in space, 84, 231
Infrared
  astronomical satellite, 144
  imaging, 47
  spectrum, 95, 146
  surveillance, 45
  water-vapor radiometer, 17
INSAT-1, 164
Institute of Electrical and Electronics Engineers, 88
Institute of Space and Aeronautical Science (Japan), 41, 212
Intelsat, 3, 10, 15, 33, 47, 58, 68, 113, 118, 143, 145, 162, 166, 171, 198, 217, 223, 264, 277, 280, 297, 301, 314
  expenditures, 3, 119
Intelsat IV-A, 2
Intelsat IVA F-3, 2, 3
Intelsat IVA F-6, 3
Interceptor satellites, 28, 64, 77, 89, 123, 130, 265, 275
Intercosmos 18, 277
International Academy of Astronautics, 91
International Aeronautic Federation, 126
International Civil Aviation Organization, 6, 20, 92, 107, 173, 203
International cooperation, 92, 97, 111, 117, 146, 165, 177, 183, 188, 198, 202, 210, 238, 280, 294, 299, 307
  U.S. and Europe, 15, 83, 107, 143
International cooperation. See also USSR, 92
International Council of Scientific Unions, 146, 299
International Geophysical Year, 17, 62
International Hydrodynamics Co., 83
International Magnetospheric Study, 143
International Maritime Satellite Observation (INMARSAT), 223

International Telephone and Telegraph, 96
International Ultraviolet Explorer, 15, 16, 34, 70, 186, 243
International Union of Geodesy and Geophysics, 112
Interstellar wind, 32
Ionosphere, 221
Iran, 12
Ireland, 92
ISEE (satellite), 177, 192, 198
ISEE 3, 276
ISEE C, 165
Italy, 12, 33
Itek Optical Systems Division, 222
ITT World Communications, 114
IUE (satellite), 166
Ivanchenkov, Alexander, 150, 176, 254, 261, 298
Jackson State University, 39
Jaehn, Sigmund, 261
Jaffe, Leonard, 106
Jähn, Sigmund, 200
Japan, 3, 5, 12, 41, 51, 94, 97, 119, 149, 198, 212
Japan Science Society, 79
Japanese Broadcasting Corp., 52
Japanese Defense Agency, 28
Japanese Maritime Science Promotion Foundation, 79
Jay, Peter, 280
Jefferys, William, 110
Jennings, Donald, 183
Jet Propulsion Laboratory, 16, 300
  contracts, 249
  missions, 50, 57, 86, 96
  people, 87, 88, 169, 197
  programs, 158, 240
Jian-Cheng, Wu, 170
Johns Hopkins University, 110
Johnson, C. Curtis, 155
Johnson, David, 243
Johnson, Lyndon, 231
Johnson, Marshall, 123
Johnson Space Center, 59
  contractors, 50
  contracts, 222
  people, 8, 12, 172
  programs, 42, 56, 87
Johnston, David, 114
Joint American-Soviet Particle Intercalibration Project, 228
Joint Chiefs of Staff, 1
Jupiter (planet), 86, 91, 105, 148, 191
Jupiter (launch vehicle), 2, 12, 16, 84, 210, 241
Kayex, Corp., 240
KC-135 (aircraft), 35, 225
Keldysh, Mstislav, 148
Kennedy Space Center, 2, 11
  contractors, 6
  contracts, 83, 129, 136, 156

  missions, 4, 15, 40, 93, 96, 262
  people, 12
  programs, 7, 27, 33, 49, 111, 295
  Spaceport, 130, 136
Kenya, 90
Kevlar, 50
Keys, John, 223
Killer satellites, 17, 28
Kinberg, Robert, 255
Kirhofer, William, 96
Kirk, Robert, 32
Kissel, Ralph, 120
Klein, M. J., 197
Klimuk, Pyotr, 150
Kline, Raymond, 214
Kluicke & Soffa Industries, Inc., 240
Kovalenok, Vladimir, 150, 176, 254, 261, 298
Kraft, Jr., Christopher, 114, 165, 191, 231
Kramer, James, 214
Kresge Eye Institute, 14
Kubasov, Valery, 160
Kuhn, Peter, 17
Kuo-feng, Hua, 19
Kurfess, James, 215
L-5 Society, 276
Lambert, K. L., 110
Lampton, Michael, 129, 188
Landing system, 173
Landsat, 57, 67, 68, 166, 187, 205, 244, 272, 298
  contractors, 52
Landsat 1, 12
Landsat 2, 7, 12
Landsat 2 and *3*, 247
Landsat 3, 53, 97
Landsat C, 7, 11, 40
Landsat D, 7, 11, 30, 159
Langley Research Center, 3, 18, 66
  contracts, 85, 189, 237, 277
  people, 103, 107, 161, 171, 213, 217, 299
  programs, 201
Large Area Crop Inventory Experiment, 188, 272
Large Space Systems Technology, 18
Laser-heterodyne radiometer, 37
LaserCom, 287
Lasers, 17, 29, 41, 71, 77, 83, 141, 185, 203, 206, 286
Latapie, Francis, 15
Lawless, James, 137
Learjet, 18
Leasat, 147, 216, 280
Leckrone, David, 166
Leonov, Aleksey, 69
LES 8 and *9* (satellites), 22
Lewandowski, Bohdan, 247
Lewis, Charles, 62, 238

Lewis Research Center, 14
  contractors, 60
  contracts, 2
  missions, 53
  people, 19
  programs, 39, 82, 105, 156
Lichtenberg, Byron, 129
Lilly, William, 75
Lind, Don, 32
Lindberg, Anne Morrow, 107
Lindberg, Charles A., 311
Linsky, Jeffrey, 70
Liquid-fuel rocket, 2, 6, 104, 169
Lissaman, P.B.S., 70
Lixiscope, 190
Lockheed International, 89, 114, 145
Lockheed Missiles and Space Co., 6, 111, 158, 184, 241
Lockheed-Georgia Co., 5
Lomas, Lucius, 264
Lomax, Harvard, 35
Long Duration Exposure Facility, 3, 31, 133
Loomis, Vincent, 83
Lorre, Jean, 169
Los Alamos Scientific Laboratory, 64
Loudenslager, Leo, 126
Louis Pasteur University (France), 278
Lousma, Jack, 161
Lovelace, Alan, 44, 133, 248, 252, 255
Lovell, Jim, 99
Lucas, William, 35
Lucid, Shannon, 8
Lunar and Planetary Institute (Texas), 55
Lunar Curatorial facility, 38
Lundin, Bruce, 248, 254
Lunney, Glynn, 191
Lushina, Louis, 33
Lynn, Donn, 169
MacCready, Paul, 46
Magion, 277
Magnavox, 130
Magnetosphere, 143, 147, 177, 212
Makarov, Oleg, 7
Malaga, Joseph, 195
Malfunctions, 80, 83, 88, 111, 187, 241, 248, 271
Malkin, Mike, 75
Management Services, Inc., 136
Mannen, James, 254
Manring, Lewis, 137
Mapping, 187, 233, 285, 298
Marecs (satellite), 198, 223, 280
Marine Corps, 8
Mariner 9, 266
Marisat, 280, 314
Marks, Alvin, 154

Marots-A, 207
Mars, 44, 50, 56, 88, 163, 174, 266
  White Rock, 267
Mars airplane, 300
Marshall Islands, 83
Marshall Space Flight Center, 10, 11, 16, 22, 25
  contractors, 30, 193
  contracts, 135, 184, 296
  ground control laboratory, 31
  missions, 71
  people, 21, 49, 178
  programs, 6, 7, 13, 15, 27, 34, 41, 109, 141, 160
Martin Marietta Aerospace, 313
Martin Marietta Corp., 13, 45, 65, 78, 90, 113, 119, 156, 159, 294, 296
Mason, Brian, 144
Massachusetts Institute of Technology, 193
Materials processing (in space), 30, 150, 219, 233
Maverick (missile), 312
MB Associates, 240
McBride, Jon, 8
McCall, Robert, 163
McCarthy, John, 19
McDonnell Douglas Astronautics Co., 65
McDonnell Douglas Corp., 17, 46, 54, 89, 247, 296, 313
McMurtry, Tom, 68
McNair, Ronald, 8
McRee, Griffith, 200
McTigue, John, 68
Mechanical Technology, Inc., 68
Media, 249
Medicine, 87, 105, 107
Meetings, 10, 14, 18, 21, 32, 41, 55, 66, 70, 81, 88, 107, 114, 122, 142, 161, 171, 185, 188, 195, 213, 216, 236, 243, 246, 247, 265, 268, 273, 292, 296
Menrad, Wesley, 152
Merbold, Ulf, 188
Mercury (planet), 56
Mercury (spacecraft), 42, 79
Mercury Co., 237
Mercury-Atlas, 79
Mercury-Redstone, 79
Messerschmitt-Bolkow-Blohm, 171
Meteorites, 37, 144
Meteorology, 31, 49, 60, 109, 142, 161, 177, 189, 204, 209, 252, 271, 283, 299
Meteosat system, 129, 213
Meteosat 1, 84, 282
Meteosat 2, 206, 304
Methane (in space), 182
Mexico, 264
Micro Craft, Inc., 66
Micrometeorites, 4, 13, 32, 176
Microwave scanning-beam landing system, 83, 92, 158, 173, 202. See also Time reference scanning-beam/microwave landing system.
Midwest Research Institute, 63
Miller, R. B., 96

Miller, R. H., 35
Miller, Richard, 167
Mineral exploration in space, 80, 166
Mini-Sniffer (aircraft), 300
Minority employment, 7, 8, 39
Mission specialists, 8, 41
Models, 6, 53, 56, 66, 205, 233, 286, 301
Molniya 3 comsat, 13
Molniya program, 10
Mongolia, 49, 69
Monitoring
  earth resources, 40, 53, 95, 121, 145, 158, 159, 176, 187, 205, 212, 241, 271, 298
  space-based, 31, 82, 159, 188, 230, 239, 266
Morgan, Walter, 108
Morrison, James, 33
Moseson, Merland, 255
Motorola, Inc., 240
Muckelstone, Robert, 154
Mueller, George, 68
Mullane, Richard, 8
Multispectral scanner system, 40, 53
Murray, Bruce, 300
MX (missile), 1, 2, 126, 153
Myers, Dale, 45
Mylar, 50
Nagel, Steven, 8
Nagoya University, 42
Narimanov, Georgy, 80
NASA-928 (aircraft), 88
National Academy of Engineering, 77
National Academy of Sciences, 75, 238
National Aeronautic Association, 46, 56, 82, 125
National Aeronautics and Space Administration
  budget, 10, 11, 30, 52, 57, 67, 92, 93, 103, 106, 188, 250
    impact on GNP, 63
  contractors, 30, 90, 114, 153, 159, 303, 305
  contracts, 151, 156
  End-to-End Data Systems (NEEDS) project, 10
  expenditures, 152, 155
  ground facilities, 50
  launch schedule, 308
  management, 4, 5, 10, 33, 44, 106, 172, 231, 250, 252, 270
  minority businesses, 181
  minority employment, 39
  missions, 49, 57, 256
  Office of Aeronautics and Space Technology, 28, 99, 152, 185
  Office of Space and Terrestrial Applications, 23, 25, 106, 142
  Office of Space Science, 122, 285, 290
  Office of Space Transportation Systems, 52
  people, 11, 20, 22, 33, 49, 91, 96, 99, 135, 178, 199, 213
  policy, 104, 142
  programs, 67
  research, 14, 15, 17, 31, 38, 63, 97, 142
  small business activity, 310

National Aeronautics and Space Administration Communications Network (NASCOM), 219
National Business Aircraft Association, 185
National Center for Atmospheric Research, 87
National Environmental Satellite Service, 176, 209, 243
National Eye Institute, 105
National Investigations Committee on Aerial Phenomena, 74
National Medical Association, 190
National Oceanic and Atmospheric Administration, 1, 5, 13, 17, 18, 31, 68, 94, 109, 116, 122, 142, 146, 161, 176, 178, 210, 273
  Wallops Flight Center, 86, 90, 181, 201, 211, 235, 260
National Parachute Test Range, 55, 90, 106, 222
National Radio Astronomy Observatory, 183
National Remote Sensing Agency (India), 7
National Research Council, 74, 81, 235, 302
National Rocket Club, 91
National Science Foundation, 30, 31, 37, 43, 44, 144, 211, 270
National Security Council, 161
National Space and Technology Laboratory, 96, 261
National Space Club, 200
National Space Development Agency (Japan)
  Broadcasting Satellite for Experiment Purposes, 51
National Space Technology Laboratories, 12, 119, 182, 252
National Taxpayers Union, 196
National Transonic Facility, 253, 277, 302
Nato 3C, 260, 275
Naval Electronic Systems Command, 26
Naval Research Laboratory, 159, 168, 296
Navigation systems, 177, 286
NavStar, 100, 130, 134, 177, 286
NavStar 2, 118, 203
Navy, 5, 8, 17, 21, 25, 26, 52, 94, 99, 121, 176, 270
Nellis Air Force Base, 83
Nelson, George, 8
Nelson, Jr., David, 268
Nesterov, Peter, 126
Netherlands, 144, 163
Newcomb Cleveland Award, 35
Newman, Larry, 199
Nicollier, Claude, 188
Nike-Apache (rocket), 228
Nimbus 6, 42
Nimbus B, 212
Nimbus G, 11, 201, 213, 220, 230, 245, 247, 253
Nippon Electric Co., 10
Noise standards (aviation), 32
NOISEMAP, 204
Nola, Frank, 105, 137, 259
NORAD, 218
Norris, T. Bland, 255
North American Rockwell, 98
North Carolina A&T State University, 39
Northern Research and Engineering Corp., 293
Nosaka, K., 145

O'Conner, Joseph, 147
O'Leary, Brian, 80
O'Neill, Gerald, 116
O'Sullivan, D., 32
OAO 2, 16
Obayashi, Tatsugo, 41
Observances, 175, 221, 227, 231, 249, 255, 311
Observations
  space-based, 34
Observatories
  ground-based, 36, 277
  space-based, 15, 20, 70, 85, 94, 109, 120, 132, 214, 239, 247, 262, 269, 276, 283
Ocampo-Friedman, Roseli, 43
Ockels, Wubbo, 188
Odetics Corp., 145
Odyssey (Apollo mothership), 98
Ogarkov, Nikoli V., 77
Onizuka, Ellison, 8
Orbit 81, 310
Orbita network, 14
Orbiting Astronomical Observatory 3, 12
Orbiting relay stations, 22
Oscar D, 53
Ots (ESA satellite), 59
Ots 2, 109, 149, 246
OTS A, 88, 149
Out of Ecliptic program, 11
Oxford University, 61
Ozone monitoring, 88, 212
P80-2 mission, 45
Paarlberg, Don, 273
Pacific Northwest Regional Commission, 67
Page, Thornton, 170
Pan American World Airways, 151
Papago Construction Co., 112
Parachutes, 55, 90, 100, 106, 125, 209, 222, 266, 300
Parker, Robert, 183
Particle-intercollabertion project, 112
Patchett, Bruce, 94
Patterson, N. Paul, 94
Patton, Jr., James, 216
Payload specialists, 184, 188, 238
Payne, Randolph, 145
Pegasus program, 218, 286
Penaranda, Frank, 22
People's Republic of China, 17, 19, 26, 81, 227, 245, 272, 284, 307
Perkin-Elmer Corp., 6
Perras, Marcel, 145, 301
Peterson, Laurence, 215
Petrov, Boris, 14
Phobos, 2
Pierce, John, 27
Pinson, Larry, 230
Pioneer, 96, 117, 123, 138, 173, 194, 233, 240, 270, 280, 293, 299, 305

Pioneer 11, 1, 84, 170
Pioneer Venus, 61
Planetary exploration, 50
Planning Research Corporation, 129
Plasma-interaction experiment, 53
Plessey Corporation, 20
Podraczky, Emeric, 15
Pogue, William, 224
Poland, 49
Policy
  research, 21
  science, 260
  social, 80
  space, 1, 33, 241, 249, 274, 289
Pollution, 11, 88, 97, 145, 174, 212, 215, 230, 245
Porter, George, 137
Poseidon (missile), 82
Postal Service, U.S., 163, 279
Power sources
  batteries, 96
  electric, 103, 105
  microwave, 80, 107, 116
  nuclear, 115
  renewable, 103, 156, 265
  solar, 16, 26, 80, 89, 115, 156, 175, 240, 249
Power systems
  nuclear, 275
Powersats, 93, 196
Prague Institute of Geophysics, 277
Presidential Command Network, 25
Press, Frank, 26, 30, 122, 161, 260, 307
Price, Melvin, 46
Princeton University, 109
Prinz, Dianne, 94, 184
Progress 1, 12, 29, 31, 36, 104
Progress 2, 176, 187
Progress 2, 3, and *4*, 261
Progress 3, 193
Project Cameo, 255
Propulsion systems, 196
Proxmire, William, 183, 188, 211
Public opinion (space program), 154
Puddy, Donald, 62
Puerto Rico, 164
Pyrheliometers, 13
Quiet short-haul research aircraft, 174, 190
Radar, 155, 199, 271, 273
Radio Research Laboratories of Japan, 52
Radio systems, 42, 86
Radio waves, 191, 197
Radiometers, 17, 37, 74, 95, 146, 159, 181, 210, 252, 271
Rand, Robert, 87
Rapp, Rita, 245
Rasool, Ichtiaque, 23, 148

Ray, Dixy Lee, 67
RCA Corp., 49, 89, 196, 219, 221, 240, 279, 283, 291, 310
RCA Global Communications, 114
Recovery systems, 90
Redstone (launch vehicle), 16
Reed, Dale, 300
Reeder, John, 217
Reentry, 218
Reentry flight dynamics simulator, 139
Remek, Vladimir, 49
Remote sensing, 7, 12, 34, 81, 95, 123, 166, 295
Research
  atmospheric, 263, 300
  aviation, 96
  biomedical, 114
  climate, 31
  computer systems, 72
  design, 51
  expenditures, 48
  funding, 259
  grants, 35, 44
  high energy, 291
  high pressure, 269
  human, 295
  lunar, 211
  magnetic field, 80
  medical, 49
  ocean, 89
  scientific, 306
  solar, 184, 247
  space colonization, 276
Research and development, 4, 142, 158, 185, 188, 195, 244, 289
  budget, 260
  funding, 103, 313
Resnick, Judith, 8
Resources monitoring, 21
Ride, Sally, 8
Riggins Company, Inc., 253
Robinson, Henry, 166
Rockwell International Corp., 39, 56, 63, 114, 119, 125, 134, 139, 158, 182, 286, 301
  Rocketdyne Division, 75
Rolls Royce Ltd., 171
Romanenko, Yuri, 31, 56, 151, 224
Romania, 49, 263
Rood, Jack, 154
Rosenblum, Louis, 175
Rostafinski, Wojciech, 62
Roth, William, 188
Rotor systems research aircraft, 86, 229
Rowe, Herbert, 22
Royal Aeronautical Society, 101
Ruloff, Arthur, 268
Rupp, Charles, 120
Safety

  aviation, 32
Saito di Quirra, 33
SALT, 2
Salyut program, 30
Salyut 2, 291
Salyut 3, 290
Salyut 4, 70
Salyut 5, 14, 290
Salyut 6, 7, 12, 13, 30, 31, 36, 39, 56, 70, 104, 176, 193, 200, 224, 227, 254, 261
Salyut 6/Soyuz 29, 150
Salyut 27, 30
SAMSO, 127
San Andreas Fault Experiment, 141
Sanchini, Dominic, 75
Sas 3, 193
Satcom-3, 291
Satellite charing at high altitudes (SCATHA), 294
Satellite Communications Terminal Program Office, 22
Saturn (planet), 1, 2, 84, 87, 170, 210, 241
Saturn (rocket), 4, 72, 78, 79, 218
Saudi Arabia, 33
Scanning beam microwave landing system. See Microwave scanning beam landing system.
Scatterometers, 271
Schjeldahl Corp., 50
Schmitt, Harrison, 35, 75, 104, 232, 251, 289
Schneider, William, 99, 214
Schoenfelder, V., 215
Schroeder, D. J., 109
Science Research Council (UK), 15, 60
Scobee, Francis, 8
Scott, David, 35, 136, 300
Scott, Sheila, 154
Scout (launch vehicle), 90, 95, 99, 163, 262
SDC Integrated Services, Inc., 85
Search for extraterrestrial intelligence, 66, 106
Seasat, 57, 89, 100, 121, 134, 144, 176, 223, 241, 247, 248, 254, 271
SeaSat 1, 158
Seasat A, 11
SeaSat Users Research Group Europe, 247
Seddon, Margaret, 8
Senate, U.S. See Congress, U.S., 75
Sensor systems, 40, 58
  spacecraft, 34, 74, 77, 95, 177, 212, 236
Sensor Technology, Inc., 241
SEPAC (space experiments with particle accelerators), 41
SETI program, 220
Shakar, Mohamed, 164
Shaw, Jr., Brewster, 8
Shepard, Alan, 225
Shklovsky, Iosif, 115
Short, Nicholas, 166
Shramo, Daniel, 255
Shriver, Loren, 8
Shroud of Turin, 169

Sikorsky Aircraft, 86
Siltec Corp., 241
Simokaitis, Frank, 213
Simon, George, 94, 184
Simulation, 139, 156, 167, 174
Sky Van (aircraft), 201
Skylab, 12, 36, 61, 65, 71, 78, 82, 106, 115, 120, 140, 156, 164, 224, 249, 259, 302
Skylab 4, 56, 168
Slayton, Donald "Deke", 42, 221, 231
Smith, Aubrey, 260, 293
Smith, Bruce, 167
Smith, Richard, 178
Smithsonian Institution, 38, 42, 45, 144, 296
  Center for Earth and Planetary Studies, 164
  National Air and Space Museum, 79, 199, 263, 297
Snap 10A test vehicle, 18
Snow, Harold, 87
Societe Europeenee de Propulsion (France), 7, 294
Society for Automotive Engineers, 152
Solar activity, 32, 37, 57, 122, 147, 165, 192, 198, 214, 235, 276
Solar conversion devices, 16
  arrays, 26, 66, 78, 112, 132, 172, 184, 194, 219, 239, 248, 272
  cells, 132, 168, 171
  collectors, 194 See also Power sources, solar.
Solar system
  primordial matter, 37
Solar wind, 84
Solar-Polar
  see Out of Eliptic program, 11
Solid-fuel rocket, 4, 10, 16, 49, 54, 83, 88, 90, 100, 106, 111, 260, 271, 313
Sollos, Inc., 241
Sonnemann, Harry, 178
Soviet Academy of Sciences, 14, 80, 148
Soyuz 18, 56
Soyuz 21, 14
Soyuz 24, 14
Soyuz 26, 7, 13, 56, 224
Soyuz 27, 7, 12, 13, 31, 39
Soyuz 28, 49
Soyuz 29, 176, 200, 224, 261
Soyuz 30, 150, 176
Souyz 31, 200, 254, 261
Space
  construction, 18, 84
  food, 245
  medicine, 13, 91, 111, 151, 262
Space and Missile Systems Organizations (Air Force), 45
Space and Missile Test Center, 286
Space Computational Center, 179
Space debris hazards, 18
Space processing applications rocket, 219
Space Shuttle, 25
  costs, 44, 117, 218, 251
  crews, 7, 8, 39, 61, 278

  designation system, 197
  experiments, 3
  external fuel tank, 6, 178
  funding, 44, 220
  launches, 115, 195, 277
  management, 295
  missions, 12
  orbiter, 4, 6, 11, 44, 50, 52, 69, 91, 93, 104, 114, 158, 183
  payloads, 3, 12, 16, 18, 20, 29, 30, 32, 36, 40, 38, 50, 57, 82, 89, 91, 106, 110, 111, 124, 156, 161, 164, 222, 273, 285, 297
  policy, 90
  problems, 226
  propulsion, 6, 10, 19, 54, 72, 75, 80, 84, 90, 96, 182, 223, 253, 261, 272, 292
  safety, 107
  systems, 120, 138, 155
  testing, 7, 21, 42, 54, 60, 69, 72, 81, 83, 90, 96, 103, 106, 119, 121, 132, 149, 156, 182, 222, 232, 242, 252, 253, 271, 292, 302
  upper stages, 90
Space stations, 80, 85, 149, 161, 232
Space Telescope, 6, 11, 16, 20, 21, 109, 110
Space Transportation System, 41, 133
Space walk, record, 176
Spacecraft charging at high altitudes (SCATHA), 312
Spaceflight Tracking and Data Network, 51, 205
Spaceflight Tracking and Data Network station, 21
Spacelab, 21, 30, 95, 117, 124, 129, 134, 168, 183, 188, 296
  costs, 285
  crew, 308
  experiments, 94, 309
  funding, 290
  management, 25, 41
  payloads, 29, 160, 284
  preparations, 27, 33, 217, 238, 264
SPAR V, 219
Spectrometers, 283, 293
Speer, Fred, 34
Sperry Rand Corp., 296
Spin research vehicle, 225
Sports coverage by satellite, 146
SRI International, 189
Stafford, Thomas, 10, 45, 191
Stanford University, 39
State University of New York, 109
Steffen, C. J., 145
Stennis, John, 9
Stereosat program, 93, 220
Stevenson, III, Adlai E., 75, 229, 251, 289
Steward, Robert, 8
Stitt, James, 255
Strategic Air Command, 11, 26
Straub, Robert, 67
Strong, Keith, 94
Submarines, 131, 203
Sullivan, Kathryn, 8

Super Guppy (aircraft), 301
Supersonic transport, 216
Surveillance, 223, 265, 275, 290
  infrared, 45
  ocean, 270
  submarine, 131
Swain, Charles, 201
Sweden, 92
Swigert, Jack, 98
Symposium. See meetings, 59
Syncom-4, 38
Synthetic-aperture radar, 199
System for nuclear auxiliary power (SNAP), 115
Systems, computer. See Computer systems.
Systems Development Corp., 68
Syvertson, Clarence, 99, 263
Taurus-Tomahawk, 260
TD 1 satellite, 16
Teague, Olin, 93, 213, 230, 238
Technische Universitat (Austria), 264
Technology
  applications, 12, 27, 41, 52, 79, 236, 314
  future, 107
  transfer, 7, 62, 100, 122, 161, 172, 245, 284, 307
  utilization, 190, 201, 260, 286
Technology Utilization House, 201
Teledyne Brown Engineering, 40
Teleoperator retrieval system, 71, 156, 183, 220, 259, 302
Telesat, 314
Telesat D, 289
Telescopes, 35, 36, 145, 168, 186, 216, 243, 262, 276, 283
  radio, 197
  satellite's, 15
Television systems, 49, 50
Telos Computing, Inc., 302
Temple 2 comet, 88, 229
Terhune, Charles, 255
Terrell, Norman, 49
Testing
  aircraft, 139
  equipment, 30, 105
Texas A & M, 109
Thagard, Norman, 8
  3B (Spacecraft), 78
Thermal protection system tiles, 252
Thiokol Corp., 10, 19, 55, 153, 252, 253, 271
Thomas, Roger, 309
Thompson, A., 32
Thompson, J.R., 75
Thompson, Robert, 42, 191
Thor (missile), 17
Thor/Agena, 265
Time reference scanning-beam/microwave landing system, 5, 6, 20, 107. See also microwave scanning-beam landing system.

Timothy, Adrienne, 148
Tiros-N, 11, 89, 100, 209, 221, 230
Titan, 90, 313
Titan (rocket), 2, 64, 78, 82, 134, 169, 265
Tokyo Shibaura Electric Co., 52
Tokyo University, 212
Tomahawk (missile), 5, 100, 113
Tracking, 87, 91, 159, 171, 196, 205, 246, 286
Training, 172, 188
Treaties, 33, 79, 179
Trident (missile), 82
Triska, P., 277
Truly, Richard, 61
TRW Systems, Inc., 25, 95, 98, 160, 185, 132, 268
Tuckwell, N., 145
Turegano, J. A., 197
Twiggs, Tom, 174
Uemura, Naomi, 42
UFOs, 74
UK-5, 60
Ullman, Al, 32
Ultraviolet spectrum, 15, 34, 37, 168, 186
United Kingdom, 5, 15, 16, 20, 92, 94, 119, 145, 210, 246
United Nations, 33, 39, 202, 247
United Space Boosters, Inc., 49
United Stirling (Sweden), 68
United Technologies Corp., 55, 114, 209, 296, 303, 313
University of Chicago, 45, 296
University of Florida, 68
University of Iowa, 296
University of Pittsburgh, 37
University of Texas, 110, 114
University of Tokyo, 41
Uranus, 1, 197, 268
USS Barb, 100
USSR, 12, 198
  Academy of Sciences, 306
  Cosmos program, 80, 123
  Gagarin Space Centre, 69
  Glissada, 41
  Intercosmos program, 49, 150
  international cooperation, 9, 14, 39, 49, 55, 112, 263, 303
  lunokhod moon-rover (USSR), 80
  manned space flights, 7, 13, 65, 176, 227, 261, 290, 298
  space activities, 29, 39, 69, 80, 187, 214, 224, 227, 254, 263, 275, 304, 306
  space stations, 56
  SST, 43
  technology, 28, 41
  Tupolev TU-95, 65
  weapons systems, 17, 29, 77
  See also Salut, Soyuz, and Venera
Van Allen, James 17
Van Allen radiation belts, 16
Van Hoften, James, 8

Vandenberg Air Force Base, 5, 6, 7, 11, 89, 90, 95, 97, 100, 115, 159, 227
Vanguard project, 17, 62
Vaughn, Jr., Otha, 60
Vaughn, Pat, 67
Vela, 233
Venera missions, 117, 273
Venera 11 and *12*, 214, 306
Venus, 61, 80, 117, 173, 194, 214, 273, 293, 299, 306
Venus (planet), 96, 123, 138, 233, 240, 270, 280
Venus-orbiting imaging radar, 199
Verbeek, Earl, 187
Viking
  lander, 79
  orbiter, 2, 174
  project, 35, 44, 89, 267
Viking 1, 163
Viking 2, 163
Villafranca station (Spain), 16
Voight Corp., 32
Von Braun, Werner, 10
VORTEX (Venus orbiter radiometric temperature experiment), 61
Vought Corp., 17, 90, 116, 262
Voyager project, 158, 192, 210, 219, 241
Voyager 1, 2, 105
Voyager 1 and *2*, 306
Voyager 2, 1, 2, 86
Waldheim, Kurt, 247
Walker, David, 8
Walker, Joe, 301
Wallops Flight Center, 86, 90, 181, 201, 211, 235, 260
WB-57F (aircraft), 87
Weapons systems, 28
  aircraft, 9
  lasers, 29, 71, 77, 185
  missiles, 1, 5, 46
  nuclear, 17
  space-based, 17, 64, 77
Weiss, Ted, 104
Wenzel, K. P., 32
Western Test Range, 5, 286
Western Union Corp., 155, 196
Western Union International, 114
Western Union Space Communications, Inc., 307
Westlake, Reginald, 15
Whitcomb, Richard, 185
White, II, Edward, 231
White Sands Missile Range, 286
White Sands Test Facility, 195, 228
Williams, Dell, 255
Williams, Donald, 8
Wind sheer, 227
Wind tunnels, 35, 51, 64, 66, 99, 103, 205, 209, 233, 253, 277, 302
Wind-turbine electric generators, 164, 171, 265

Winglets, 35, 255
Winstead, Thomas, 178
Winter, David, 14, 114
Wisner, William, 154
Women, 7, 8, 83, 94, 107, 148, 184, 295
Wood, H. William, 15
Woodley, William, 162
Workshop. See meetings, 66
World Data Centers, 300
World Meteorological Organization, 229
World Weather Watch, 299
Wright, Wilbur and Orville, 206, 297
X-15 (aircraft), 249
X-rays, 34, 35, 60, 78, 95, 120, 163, 186, 190, 193, 239, 243, 262, 268, 275, 283
Xenon, 268
XFV-12A (aircraft), 139
XV-15 (aircraft), 64
Yardley, John, 75, 191, 197, 214, 225, 289, 303
YF-12 (aircraft), 92, 296
Yin, Lo I., 190
Young, John, 61, 191
Young, Richard, 43
Young, Thomas A., 263
Zaire, 33
Zisfein, Melvin, 199

C-5

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